

January 2015

# Cocoa-Chocolate Supply Chain Educational Board Game Design

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**PURDUE UNIVERSITY**  
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Entitled

COCOA-CHOCOLATE SUPPLY CHAIN EDUCATIONAL BOARD GAME DESIGN

For the degree of Master of Science

Is approved by the final examining committee:

Edie Schmidt

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Approved by Major Professor(s): Edie Schmidt

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Head of the Departmental Graduate Program

10/15/2015

Date

# COCOA-CHOCOLATE SUPPLY CHAIN EDUCATIONAL BOARD GAME DESIGN

A Thesis

Submitted to the Faculty

of

Purdue University

by

Ye (Sophia) Zhao

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science in Industrial Technology

December 2015

Purdue University

West Lafayette, Indiana

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## ABSTRACT

Zhao, Ye. M.S., Purdue University, December 2015. Cocoa-Chocolate Supply Chain Educational Board Game Design. Major Professor: Edie Schmidt.

This research provided educators a systematic review of the gaming elements that needed to be utilized while designing an educational board game. This thesis provided an example of implementing the design methodology, developing an educational game designed to address the Hockey-stick phenomena demand pattern within a cocoa-chocolate supply chain. The Cocoa-Chocolate Supply Chain Educational game design was validated through a retrospective survey to support the methodology. Furthermore, recommendations were listed at the end of this thesis to support future research.

By playing the cocoa-chocolate supply chain game, the students knew more about the hockey-stick phenomena which was usually lack of attention from the college education. This game provided students with deeper understanding of the real-life problems of the cocoa-chocolate supply chain, which they might incur in their future career, and prepare them for responding to such problems by simulating the risks and frustrations that caused by hockey-stick phenomena (Sparling, 2015). By using an educational game to deliver the necessary knowledge, the students were able to actively involved in the learning process and gain deeper impression (Balasubramanian& Wilson, 2005).



This research not only filled the knowledge gap of hockey-stick phenomena in supply chain education, but also provided the researchers and educators with a more systematic and comprehensive way of designing an educational board game. During the research, very limited literatures were found in this area. This research combined and modified some of the existing design methods, and provided a new perspective of how to design educational board game.

## CHAPTER 1. INTRODUCTION

This research addressed the hockey-stick demand pattern within supply chains.

The hockey- stick phenomenon can result in resource waste and unnecessary costs during the slow sales period, which can increase supply chain variable costs such as storage, maintenance and other expediting fees. High quantity sales periods can result in a backlog of products, which can influence the logistical performance of the supply chain and lead to a negative impact on company profits. This phenomenon is widely observed in many different companies and industries (Lee& Whang, 1997). Understanding this demand phenomenon is important for the educational and industrial training.

The chocolate industry is one in which raw material cocoa beans is harvested only several months within a year and the crop success depends on the actual temperature during the harvesting month (Wikipedia, 2015). So the cocoa bean production varies and adds the demand variability in the food industry complicated the processes. Food products also have an expiration date making it even more important to control the hockey-stick phenomenon to avoid backlog and product waste. Usually the shelf-life of chocolate varies from 12 to 24 month depending on the chocolate type and preservation temperature (Stauffer, 2015). The report from Hersey (QUARTZ, 2014) showed that the chocolate sales quantity usually increases dramatically during the last quarter and first quarter of the year (Holiday seasons: Thanks Giving, Christmas, New Year, and

Valentine's Day). The unstable demand, limited shelf-life and uncertain harvesting season make the cocoa-chocolate supply chain an ideal candidate for developing the educational game to address the hockey-stick demand.

Interactive classroom instruction has been a popular method of delivering knowledge to students. Recently, Purdue University has moved to revise traditional lectures with interactive instructions so this research implemented the educational gaming, a type of interactive study method, to deliver the supply chain knowledge to the students.

The end product of this research was designed to be an interactive educational board game, validated through testing with undergraduate students. Results showed that the game contributes to students' knowledge of supply chain management and the hockey-stick demand. Furthermore, the research provided a systematic analysis of the process of designing an educational board game.

### 1.1 Research Question

What gaming elements should be utilized when designing an interactive board game to enhance college students' understanding of the challenges and risks associated with supply chain processes that were influenced by the hockey-stick demand?

### 1.2 Statement of Purpose

The purpose of the research was twofold:

- 1) The research aimed to expand the understanding of the hockey-stick demand for students and inspire them to explore strategies to optimize supply chain performance through the educational board game.
- 2) Identify the gaming elements to be utilized and the processes to be implemented to design an educational board game.

### 1.3 Significance

This research mainly contributed to two different areas; first, by designing the educational game this research filled the in the college level supply chain education, which has very limited hockey-stick demand pattern relevant content. Second, the research combined and modified the existing educational board game design methods to provide a more systematic and cohesive way of designing the educational board game.

The negative effects caused by hockey-stick phenomena included increasing inventory level, back-log problem, and high operation costs etc. (Kim, 2006). Furthermore, the hockey-stick phenomenon occurs in many different industries (as cited in Hartman & Dror, 2003) such as food, automation and apparel industries. Companies expended energy and resources to try to control the occurrence of the hockey-stick phenomena (Hartman& Dror, 2003). By introducing this concept to students, they could be more prepared for the future job market. Hence, raise students' awareness of this problem could make them marketable. However, college level supply chain education still lacks activities or course content which addresses this problem.

The significant benefit that the Beer Distribution Game (MIT Sloan School of Management, 1957) brought to supply chain education and business training demonstrated that interactive study is an ideal way to help students and employees to understand the complex concepts and problems in the area and to develop strategies to address actual industry issues (Sparling, 2015). The goal of college-level education and company training is to provide students and employees with the ability to quickly adapt to real-life problems, giving examples to be solved in their future work environments (Enciso, 2011). Interactive gaming provides users with an engaging were to explore how

their individual actions and decisions could impact the corporate. (Ratwani, Knerr & Orvis, 2010). Even though the interactive study and educational gaming were important topics, and it was well recognized by their significant benefits brought to the students, very limited information was found on the methodology of designing the educational board game. Hence, this research combined and modified the existing game design method, and provided a more systematic way of designing the educational game both from the instructional information and technical design perspective. This provided the educators and researchers a more reliable and complete way of designing an educational board game.

#### 1.4 Scope

This research was based on the Beer Game model (MIT Sloan School of Management, 1957). An interactive board game was designed to inspire students and employees to develop strategies and solutions for industrial problems.

Among the various issues supply chain related companies face, the Hockey-Stick Phenomenon has become a widely recognized problem, occurring across several types of companies, asserting its influence over supply chain performance and impacting financial performance (Sanches & Lima, 2011). As a result, the research topic has been narrowed to a goal of designing an interactive game seeking to address this problem.

The chocolate industry was chosen as the context for this training game, due to the periodical demand fluctuation experienced during holiday seasons (QUARTZ, 2014). This context was expected to provide an accurate simulation of the Hockey-Stick Phenomenon. However, no specific chocolate brand was chosen. Instead, the general

process of cocoa-chocolate supply chains, especially distribution sections, was modeled to develop this interactive game.

This research identified the gaming elements needed to develop an educational board game based on the chocolate supply chain in order to demonstrate the Hockey-Stick Phenomenon, as well as some minor business problems including international trade, business communication, and shipment delay variances.

As shown in Figure 1.1, the research scope was limited to develop an educational board game by implementing the proposed game design using the cocoa-chocolate supply chain to address the hockey-stick phenomena. Furthermore, the gaming elements were identified for designing an educational game.



Figure 1.1 Scope for Research

### 1.5 Assumptions

The assumptions of this study were:

1. Lead-time between each supply chain partner involved in the cocoa-chocolate supply chain model was one or two days.
2. Raw material quantity was assumed to be unlimited without seasonal difference, which means no matter how large the order was, it could always be fulfilled by one order from the farmer.
3. Shipment quantity for each order was unlimited.
4. Demand quantities for each cycle were designed to be in a hockey-stick shape by setting the first 8 cycles with low demand quantity and rapidly increasing the quantity for the last three periods.

#### 1.6 Limitations

The limitations of this study include:

1. The final game design was tested by 33 Purdue University- West Lafayette undergraduate students major in supply chain management technology.
2. The final product of this research was limited to an educational board game designed to address Hockey-stick phenomena.
3. The literature reviewed in this research was limited to the publications that could find through internet and library resources.

#### 1.7 Delimitations

The delimitations of this study were:

1. The game design testing was limited to undergraduate students major in Supply Chain Technology from Purdue University – West Lafayette.
2. The industry background of the game designed was limited to cocoa-chocolate supply chain.

3. This game was designed to address the negative effects of the hockey-stick phenomenon on supply chain performance.
4. This research did not take dairy products involved in chocolate production into consideration; only cocoa was considered as the raw material.
5. Effectiveness evaluation was only performed on students; it did not involve evaluation of company trainees.
6. When developing the cocoa-chocolate supply chain model not all supply chain processes were considered; only the crucial ones.

### 1.8 Definitions

*Hockey-Stick Phenomenon*- The ‘Hockey-Stick Phenomenon’ refers to a large product demand occurring over several days in a fixed period, preceded by relatively small demand for the rest of the period, which forms a ‘hockey stick shaped’ graph (Snyder & Shen, 2011).

*Simulation Game*- Activities modeled from “real life”, developed into a game to achieve a different purpose (Jones, 1995).

*Retrospective Evaluation*- Evaluation of students’ baseline knowledge and program impact after implementing a program (Paul, Martinez, Premand, Rawlings & Vermeersch, 2010).

### 1.9 Summary

An overview of the research was given in this chapter by stating the research question, statement of problem, significance of the research and research scope. Key definitions, limitations, delimitations and assumptions were included to guide the analysis.



The next chapter provides necessary literature reviews to build the research argument and lay a solid foundation for constructing the research methodology.

## CHAPTER 2. LITERATURE REVIEW

This chapter provides a literature review related to supply chain simulations and educational gaming, and addresses the importance and applicability of the previous research on this research question. This section was divided into 3 sub-sections including: 1) Hockey-Stick Phenomenon, 2) Cocoa-Chocolate Supply Chain, 3) Educational Gaming and Evaluation.

The resources outlined in this chapter were gathered using the Google Scholar database. For each of the three main topics included in the literature review section, a query was used to search for resources based on each section's respective key words. Each sub-topic contributed to the investigation of the research question in different ways, as shown in Table 2.1.

Table 2.1 Literature Review Structure

Section#	Content	Search word	Contribution
<b>2.1</b>	<b>Hockey-stick Phenomenon</b>	Hockey-stick Phenomenon	Helped readers understand why the hockey-stick phenomenon need to be address
2.1.1	Definition	Hockey-stick Phenomenon	Clarified the definition of the hockey-stick phenomenon within supply chain sector

2.1.2	Stimuli	Hockey-stick Phenomenon	Identified reasons that will cause the hockey-stick phenomenon, which might also be happened while playing the game
2.1.3	Effects	Hockey-stick Phenomenon	Explained why the hockey-stick phenomenon needs to be addressed.
<b>2.2</b>	<b>Cocoa-Chocolate Supply Chain</b>	Cocoa-Chocolate Supply Chain	Helped identify the model used for game design
2.2.1	Overview	Chocolate Supply Chain	Explained why coca-chocolate industry was chosen to be the game model
2.2.2	Cocoa-Chocolate Supply Chain Model	Chocolate Supply Chain	Reviewed cocoa-chocolate supply chain model and provide reference for game design model
2.2.3	Key Factors in Cocoa-Chocolate Supply Chain	Chocolate Manufacturing	Explained in detail in supply chain process, will contribute to instructional game design
2.2.4	Issues in Cocoa-Chocolate Supply Chain	Issues in Chocolate Industry	Extended knowledge for cocoa-chocolate industry
<b>2.3</b>	<b>Educational Gaming and Simulation</b>	Educational Gaming and Simulation	Described why using educational gaming to achieve the educational propose
2.3.1	Strength	Educational Gaming and Simulation	Described the advantage of using this method.
2.3.2	Game Design Method	1) Educational Board Game Design 2) Instructional game design	Reviewed different method of educational game design, this will help determine the methodology
2.3.3	Game Evaluation	Educational game evaluation	Provided overview of game evaluation method, and help determine the evaluation methodology

## 2.1 Hockey-Stick Phenomenon

As stated by Chase and Aquilano, the Hockey-Stick Phenomenon can be observed in “just about every company” (as cited in Hartman & Dror, 2003, p. 243). Lee and Whang (1997) agreed on the widespread appearance of the Hockey-Stick Phenomenon; they stated, “The phenomenon is quite prevalent” (p. 5).

### 2.1.1 Definition

The 'Hockey-Stick Phenomenon' has various definitions including "shipping most of the demand from a factory during the last week or two of a fiscal period" (Hartman & Dror, 2003, p. 243). The Hockey-Stick Phenomenon can be defined as the demand spike in a fiscal sales period (Sanches & Lima, 2011). Sohoni et al. (2010) states that the Hockey-Stick Phenomenon is the high sales quantity occurring at the "end of the incentive period" (Sohoni, Bassamboo, Chopra, Mohan, & Sendil, 2010, p. 503). The hockey-stick phenomenon is "the unpredictable increase in sales quantity at the end of each quarter" (Kim, 2006, p. 359). Simons and Moore (1992) defined the Hockey-Stick Phenomenon as the appearance of a 'hockey stick shaped' curves that indicated low sales quantity at the beginning of the sales period, followed by sharp increases toward the end of the sales period.

Different definitions of the Hockey-Stick Phenomenon occurred as researchers defined the phenomenon from different perspectives of the business, such as sales, manufacturing, marketing, etc. 'Hockey-Sticks' in a supply chain process were defined as large leaps in product demand occurring several days into a fiscal period, with relatively small demand for the rest of the period, forming a 'hockey stick shape' in the graph (Snyder & Shen, 2011).

### 2.1.2 Stimuli

The Hockey-Stick Phenomenon is believed to have multiple causes; the most well recognized reason is the behavior of the salesman, who may be incentivized to reach the sales goals of the company (Sanches & Lima, 2011). Sohoni et al. (2010)

agreed with this point, in that periodic threshold incentives could result in higher sales at the end of each incentive period. From a retailer's perspective, the discount inspires them to purchase more products before the end of a specific period, which leads into a loop that can result in lower purchase quantities at the beginning of a sales period and cause a rapid increase at the end (Sanches & Lima, 2011). Kim (2006) believed that the Hockey-Stick Phenomenon was caused by the desire to meet the sales goals and increase sales revenue. Another possible reason stated by Desai et al. was that a retailer could chose to purchase more products and increase their inventory at the end of the period to prepare for an expected price increase at the beginning of the next (as cited in Sanches & Lima, 2011, p. 11). The Hockey-Stick Phenomenon sometimes became a tool for large retailers to negotiate deals with manufacturers; by reducing purchase volume, these retailers put pressure on manufacturers to negotiate a lower price (Sanches & Lima, 2011). The result is that these behaviors put the supply chain in a passive position, making it hard to control the effects of the phenomenon.

### 2.1.3 Effects

The main issues that the Hockey-Stick Phenomenon brings to a supply chain process are unstable demand and uncertain quantities of requested products. Various researchers have supported this point. Kim (2006) stated that the Hockey-Stick Phenomenon led to "increased variability toward upstream value chain activities" (p. 362), and was one of the fundamental internal foci that caused "sub-optimal performance" of the supply chain. He also stated that multiple areas of the supply chain were influenced by this phenomenon, including production, distribution, purchasing and forecasting. Sohoni et al. (2010) stated that the Hockey-Stick

Phenomenon would both influence ordering patterns and lead to sales variance, which results in off-site “production planning and inventory management” (p. 503).

Hartman and Dror (2003) agreed with this point and stated that the Hockey-Stick Phenomenon negatively affects “manufacturing and order fulfillment operation” (p. 244). Uncertain demand can also increase stocking costs considerably (Sohoni, Bassamboo, Chopra, Mohan, & Sendil, 2010).

The variance and irregular demand curve can cause variable costs and resources waste to rise. This point was supported by Hartman and Dror (2003); the work falls into a short time period, which increases the defect rate, quality control, and the chance of missing deadlines. Similar points were raised by Sanches and Lima (2011). They recognized that the main areas of supply chains that could be influenced by the Hockey-Stick Phenomenon are “shipping, stocking, warehousing, handling and extra hours” within the logistics areas. The cost of those activities and processes tended to increase tremendously (p. 11). When product costs remain the same, profits from spikes in volume can be wiped out after paying the increased logistics costs (Sanches & Lima, 2011). “The increase in logistics costs ended up being reflected in the company’s actual profit, obligating it to increase sales volume to cover the fall in profit margin” (Sanches & Lima, 2011, p. 11).

With all of the negative effects that the Hockey-Stick Phenomenon can potentially bring to a company, the goal is to eliminate its occurrence (Sanches & Lima, 2011). Companies invested great amount of human resources and made financial effort to reduce this effect (Hartman & Dror, 2003). Some companies even took “extreme measures” to be deadline-oriented (Hartman & Dror 2003). This was a

strong example of how important it can be for a company to develop strategies and to train employees to be aware of the phenomenon.

## 2.2 Cocoa-Chocolate Supply Chain

### 2.2.1 Overview of Chocolate Industry

Demand for chocolate has been increasing in recent years, which has also increased cocoa bean sales volume (Syahrudin, 2011). It is estimated that the demand for cocoa has steadily increased for over 30 years (Fowler, 2009). Haynes, Cubbage, Mercer and Sills (2012) stated, “70% of the world cocoa is produced by small landholders” (p. 1469). The variance of demand highly impacted the price, which caused big problems for those landholders (Haynes, Cubbage, Mercer & Sills, 2012). Fold (2002) defined the cocoa-chocolate supply chain as a passive price taker in the industry; their performance and benefits were highly impacted by the sales quantities and price changes. Fold stated, “The global cocoa-chocolate supply chain is essentially buyer-driven” (Fold, 2002, p. 244). This supply chain needed to be prepared all the time for variance in demand given to them by retailers. Therefore, it is important for the chocolate industry to respond to the Hockey-Stick Phenomenon.

### 2.2.2 Cocoa-Chocolate Supply Chain

The cocoa-chocolate industry involves many complex individual companies in the supply chain process. (Haynes, Cubbage, Mercer & Sills, 2012). Haynes, Cubbage, Mercer and Sills (2012) also stated that the cocoa supply chain is like a collaboration of different actors and some companies need to fulfill multiple roles during this process.

In order to fit the research purpose for the game's design, the cocoa-chocolate supply chain was re-modeled and re-created based on the previous literature to reach its optimal ability to educate students. Researchers had different ideas of the framework involved in the cocoa-chocolate supply chain. Stolte and Mercer (n.d.) used four main sections in their chocolate game design; the sections including cocoa farmer, producer, supermarket and customer as shown in Figure 2.1. Syahrudin (2011) divided the supply chain into four main sections including cocoa growers, middlemen, manufacturing companies and retail companies, and also created a value chain based on this, as shown in Figure 2.2. Fold (2002) developed the framework with farmers, international trading companies, international grinders, brand manufacturers and retailers. Haynes, Cubbage, Mercer and Sills (2012) divided the cocoa-chocolate supply chain into four sections including "dealers, processors, manufacturers and retailers" (p.1471) as shown in Figure 2.3, a detailed process flow map built according to these sections. Fowler (2009) used a different way to approach this problem; he divided the supply chain into producers and users of cocoa. Within the producers' section, the process started from farmer, and then went to a co-op or trader. From there the cocoa went to a larger trader or collector, which was connected to the international market by an exporter or shipper, before the cocoa proceeded to the second phase. The users section started with processors, grinders, then chocolate manufacturers, and eventually the final product was brought to retailers.



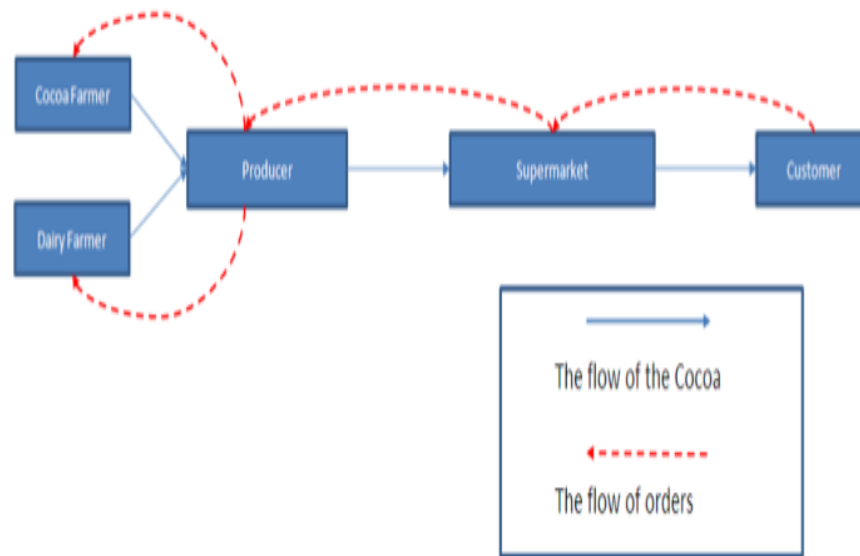


Figure 2.1 Cocoa-chocolate supply chains

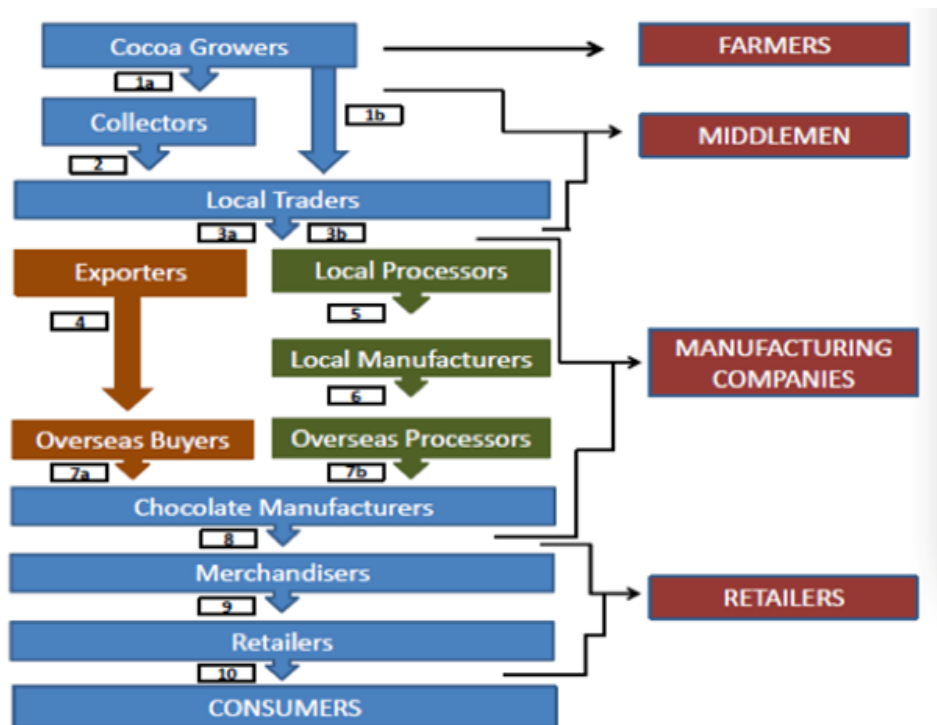


Figure 2.2 Cocoa-chocolate value chain (Bedford et. al., 2002)

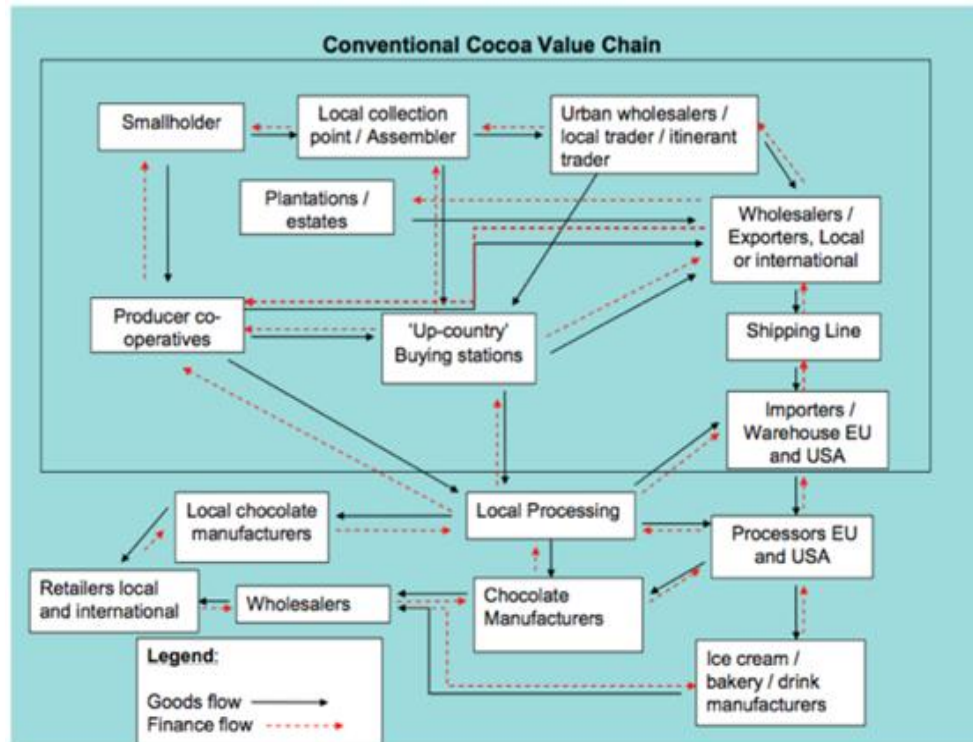


Figure 2.3 Conventional cocoa supply chain (Philips & Tallontire, 2007)

### 2.2.3 Key Factors in Cocoa-Chocolate Supply Chain

Key supply chain factors in the cocoa-chocolate supply chain included the grower, collector, processor, manufacturer, retailer, warehouse and shipment (Haynes, Cubbage, Mercer & Sills, 2012).

#### Growers

Cocoa growers usually did the fermenting and drying the beans; this was crucial to differentiate their cocoa quality from the rest of the market (Haynes, Cubbage, Mercer & Sills, 2012). Cocoa growers were categorized by their farm sizes into small producers, which need to be part of a co-operative to bring their cocoa bean to the market, and large producers, who could export their beans directly (Haynes, Cubbage, Mercer & Sills, 2012).

### Collection Agents

Collection agents collected the beans from farmers, and then sent the beans to local processors or manufacturing companies (Syahrudin, 2011). Haynes, Cubbage, Mercer & Sills (2012) stated that collectors were aggregate smaller quantity of beans into “commercially efficient quantities” (p.1472). Collection agents did not treat cocoa beans directly. However, they were the key role in achieving integration of resources and meeting the market expectations (Haynes, Cubbage, Mercer & Sills, 2012).

### Processor

Local processors bought beans from collectors and then stored the beans in their own warehouses. They produced some intermediate product by roasting or grinding the beans, resulting in intermediate products such as cocoa liquor, nibs or powder, which were then sold to manufacturers. (Haynes, Cubbage, Mercer & Sills, 2012). Cocoa collectors realized maximum benefits by selling their beans to processors instead of directly to chocolate manufacturers (Syahrudin, 2011)

### Manufacturers

Manufacturers could either purchase the intermediary product from processors or purchase the cocoa beans from collectors. However, only a few large manufacturers bought cocoa beans from collectors directly (Haynes, Cubbage, Mercer & Sills, 2012). This stage prepared a final product ready for sale (Syahrudin, 2011). Within the manufacturing process, there were several steps including blend and mix the raw material or intermediate product; cook the raw material into final product and package them for delivery. (Syahrudin, 2011, p. 6). According to

Haynes, Cubbage, Mercer and Sills (2012), manufacturers could “create the finished product that is eventually sold on the shelf” (p. 1472).

#### Retailers

This was the last stage that the chocolate needs to complete before arriving in stores. “Retail companies receive ordered products and identify them by scanning the barcode” (Syahrudin, 2011, p. 6). The basic product information were collected during this step.

#### Warehouse

The importance of the storage was critical (Haynes, Cubbage, Mercer & Sills, 2012); cocoa beans had really strict temperature and moisture requirements for storage environments (Fold, 2002). Warehouses need to be constructed waterproof, temperature controlled, and cocoa beans needed to be stored off the ground (Fowler, 2009). Additionally, they cannot be stored with anything that might cause a flavor change or other contamination (Fowler, 2009). With improvements in technology, now cocoa bean storage can use bulk or container vessels to save labor hours and costs. (Fold, 2002).

#### Shipment

Shipment methods for cocoa beans depend on port facilities and shipment quantities. Bulk shipment methods were the most widely used due to their excellent moisture control (Fowler, 2009). The shipment methods include break-bulk, sling loaded, containers, barges and mega-bulk (Fowler, 2009). Furthermore, the shipment of cocoa beans must be regulated for moisture, which requires a certain temperature

for the beans to be moved. Fowler (2009) stated that the shipment season from West Africa were usually during the winter season.

#### 2.2.4 Government Policy & Regulation

Cocoa related product importation procedure and requirements various from country to country (Kollerath, 2014). Different product categories have different requirements for quality (Kollerath, 2014). The cocoa and cocoa related products have to meet the food safety requirement provided by Food and Drug Administration if the product is being imported to the U.S. (Kollerath, 2014).

Imported product samples are collected and tested at the port, only very limited suppliers could pass without sample testing because of their histories of high quality product and good credit (Bodor, 2011). The US FDA regulation (2011) stated the cocoa beans are to be tested without shells using multi-residue method. FDA Pesticide Sampling Program (2008) published data proving that the imported cocoa beans had a violation rate of 4.2% in year 2008, and the violation rate usually various between 2.6% to 6.2%.

#### 2.2.5 Issues in Cocoa-Chocolate Industry

There are multiple issues that researchers have identified to improve industry safety and sustainability, the game focuses on the issues related to supply chain knowledge. There are three main issues faced by the chocolate industry identified through this research. The most common was the traceability of cocoa beans, which was crucial for food safety (Syahrudin, 2011). Another was “how to achieve sustainable development across the remainder of the cocoa supply chain without over production of cocoa” (Fowler, 2009, p. 28). Certification processes of the chocolate

supply chain needed to be improved and re-structured (Haynes, Cubbage, Mercer & Sills, 2012).

### 2.3 Educational Gaming and Simulation

A literature review was conducted to examine educational games and simulation from three different perspectives: strength of using gaming and simulation for training purpose, game and simulation design methods, and evaluation of educational game design. The review supported the significance of the research and provided essential knowledge of game design process.

#### 2.3.1 Strength of Using Game and Simulation for Educational Purposes

There is a famous aphorism from Confucius stated: “Tell me, I will forget. Show me, I may remember. Involve me, I will understand” (as cited in Scott, 2006, p. 20). This relays the importance of actively involving students in the learning process, especially through hands-on experience. Today, games for training purposes have become the one of the most recognized methods of involving students and filling the gap between reality and knowledge (Ratwani, Knerr & Orvis, 2010).

Balasubramanian and Wilson (2005) supported this point by stating the tremendous promise the game and simulation could facilitate the learning of the current challenges in educational training. Others have pointed out that educational games can be cost effective and offer faster results (Ratwani, Knerr & Orvis, 2010). This aligns well with our purpose of improving college education and business training. Enciso (2011) stated that games and simulations let students or trainees see how their actions influence the decision in a realistic environment, and provided them with motivation to dig into a knowledge area. Also, the author stated that games and simulations

represent the complexity of a system and explore different decisions within the without influencing the actual company operation and financial reports. Enciso pointed out the importance of learning in a dynamic environment.

Various researchers showed that there are three main advantages of learning through interactive methods such as simulation and gaming come: students' level of interest, deeper grasp of knowledge, and a risk-free environment. Research results from Randel, Morris, Wetzel and Whitehill (1992) showed that students were more passionate about interactive study such as games and simulation than about traditional class instructions. In a study by Cohen "87% of participants said that the games were more interesting than traditional teaching" (as cited in Randel, Morris, Wetzel & Whitehill, 1992, p. 268). Enciso (2001) explained this by invoking "voluntary learning" (p. 6); instead of the passive reception of knowledge from lectures, these activities gave participants a way to learn by themselves. Furthermore, gaming and simulation allowed participants to play numerous cycles, and took time think out their decisions (Enciso, 2001). This resulted in a "stronger, double-loop, learning process" (p. 7). Also, simulation and gaming gave the participants a chance to explore and test their decisions in a risk-free environment, while in the real world; actions could not be changed once they were made. During the simulation, participants broaden their decision range (Enciso, 2001).

With all the benefits that gaming and simulation learning provided, the purpose of addressing the Hockey-Stick Phenomenon can be achieved using interactive study methods including games and simulation.

### 2.3.2 Educational Game Design Methods

This section reviewed game design methods, and helped to determine the methodology, which should be used for this particular research. However, very limited literature was available in this specific area. Educational game design models for complex learning were rarely found (Enfield, 2012).

The most common used method was the Four Component Instructional Design (4D/IC) method raised by van Merriënboer, Clark and Croock (2007). This method identified the four main components of instructional design, which included learning tasks, supportive information, just-in-time information and part-task practice (Merriënboer, Clark & Croock, 2007). This game design model focused on performance coordination and skills to finish task-specific requirements instead of the game presentation media. Furthermore, the distinction between just-in-time information and supportive information were drawn through this method to avoid confusions (Merriënboer, Clark & Croock, 2007). According to Huang and Johnson (2009), there is no well-established educational game design model: they recommended 4D/IC model to game designers. They raised the point that the 4C/ID model is suitable for instructional design of the game (Huang & Johnson, 2009). Shown in Figure 4, 11 are characteristics that could support the game design process (Huang & Johnson, 2009, p. 6). Furthermore, each characteristic was included in one of the four component of the 4D/IC model (Huang & Johnson, 2009, p. 6). This proved that the 4D/IC model is a well-established instructional game design model that took game characteristics into consideration.



Based on the 4D/IC model, Enfield (2012) designed the Ten Steps to Complex Learning Method to set up a framework that could facilitate the instructor's design process in a very rich way. This method was particularly useful for educational games with complex objectives. The ten steps of the design method were shown in Table 2.2. However, this method was still mainly for instructional design rather than the design of the complete board game.

Table 2.2 Ten Steps to Complex Learning (Enfield, 2012)

Blueprint Components of 4C/ID	Ten Steps to Complex Learning
Learning Tasks	1. Design Learning Tasks
	2. Sequence Task Classes
	3. Set Performance Objectives
Supportive Information	4. Design Supportive Information
	5. Analyze Cognitive Strategies
	6. Analyze Mental Models
Procedural Information	7. Design Procedural Information
	8. Analyze Cognitive Rules
	9. Analyze Prerequisite Knowledge
Part-task Practice	10. Design Part-task Practice

Salter (2013) considered the educational board game design in three phases including Imagine, Make, Revise and Repeat. Each phase contained two or three detailed steps. As shown in Table 2.3 the detailed steps were shown below, taken from Salter (2013). This design process was especially for the educational board game design that fell into this research criterion. However, this process lacked an instructional design part.

Table 2.3 Educational Board Game Design

Phase	Detailed Design
Phase 1: Imagine	Brain storm an educational objective

	Choose a central mechanic
	Clarify your theme and concept
Phase 2: Make	Imagine game metaphor
	Design system and pieces
	Prototype your playable design
Phase 3: Revise & Repeat	Playtest your game concept
	Revise and eliminate unenjoyable parts
	Rewrite rules and material

This design method provided a framework to design an educational board game, without instructional development. However, this design method could be implemented with the 4C/ID method to form a complete educational board game.

### 2.3.3 Game Evaluation

This section reviewed literature related to educational game evaluation.

#### 2.3.3.1 Influence

Ratwani, Orvis and Knerr (2010) stated that the usefulness of a game could be determined by “examining motivation” (p. 2). A successful game should be able to “influence trainees’ motivation and the time trainees are willing to invest” (as cited in Ratwani, Orvis & Knerr, 2010, p. 2). Looi and See (2010) stated that a successful educational game should be able to engage students in a long period of learning time and motivate them to learn by themselves over the gaming period.

### 2.3.3.2 Effectiveness

There were different ways to assess training effectiveness. Effectiveness had three main factors to evaluate. They are “the game, the trainee, and the situational context” (Ratwani, Orvis and Knerr, 2010, p. 3). They also stated that the effectiveness of training could be accessed by the impact. Wilson (2005) stated that the effectiveness of an educational game could be assessed by four questions: 1) what is the educator’s need of this game? 2) Where should the educator to find a game they need? 3) How is this game used? 4) How does one evaluate the game?

### 2.3.3.3 Methodology

#### General Introduction

The educational game designed by Eagle and Barnes (2009) to improve the introductory education of computer science was evaluated by a pre-test and post-test. Ratwani, Orvis and Knerr (2010) used the same method to evaluate educational game-based training. Balasubranmanian and Wilson (2005) gave researchers a more systematic and detailed evaluation process, the pre-tests were obtained from student using their first thoughts, and then feedback after game were used as the method for after-action review, a post-test was given on the second day. Bonk and Dennen explained more about after action reviews (AAR) in their research. The maximum effect of the game can be strengthened by the after action review (Bonk & Dennen, 2005). The educational game fallen into the criteria of summative evaluation (Chen, 2013). The popular evaluative method was Kirkpatrick’s (1996) four-level evaluation, which included evaluations of reactions, learning, behaviors and results (Chen, 2003).

In this research, the educational game was evaluated from the summarized perspective, with focus on the first level of Kirkpatrick's evaluation.

#### Prospective VS Retrospective

The impact of a program can be accessed by either prospective method or retrospective method. (Gertler, Martinez, Premand, Rawlings, & Vermeersch, 2007) Prospective evaluation was to evaluate the students while implementing the program while retrospective method was to evaluate the impact after the program was implemented. (Gertler, Martinez, Premand, Rawlings, & Vermeersch, 2007) The major difference between these two methods was the execution process. Prospective evaluation needed to be executed twice: pre-test and post-test. Prospective evaluation only needed one execution, after the program, the pre-test and post-test executed at the same time (Davis, 2002).

The validity of the retrospective method was examined by the experiment of self-report Parent Ladder designed by Pratt, McGuigan and Katzev (2014). The experiment result proved that under this specific circumstance the retrospective method could evaluate the program effect more accurate than the prospective method by avoiding the bias of response shift. (Pratt, McGuigan & Katzev, 2014). There are examples of educational game evaluated by the retrospective method. David (2002) used the retrospective method evaluated the impact of a educational workshop related to strategy planning and raised a template for questionnaire. The Board of Regents from University of Wisconsin (2005) provided an example of a community educator used retrospective to evaluate the impact of the educational program of communication skills between young couples. There is no direct literature accessing

the validity of the prospective evaluation, however, there are applications using prospective evaluation for more scientific research.

There are several advantages and disadvantages of retrospective evaluation as compared to prospective evaluation. The advantage of retrospective evaluation can be summarized into four major points: 1) retrospective evaluation can avoid response shift, to improve the result's accuracy (Pratt, McGuigan & Katzev, 2001); 2) it is very beneficial for time intensive evaluation environment (Klatt & Powell, 2005); 3) it can avoid over-estimation of prior knowledge of the topic (Pratt, McGuigan & Katzev, 2001); and 4) reduces the risk of introducing the students with knowledge points before the game (Mark, 2005). The disadvantage of retrospective evaluation can be concluded into three major points: 1) it could introduce students' desire of showing the learning effect (Mark, 2005); 2) the accuracy of recalling the status before the treatment varies, hence the validity might be influenced (Klatt & Powell, 2005)' and 3) the self-report mechanism might cause inaccuracy on test results.

## 2.4 Conclusion

The literature review in this chapter focused on three major topics: (1) hockey-stick phenomenon; (2) cocoa-chocolate supply chain; (3) educational gaming and simulation. The literature reviewed provided a solid foundation for the information needed along the game design process, as well as addressed the significance of this game.

By reviewing the literatures related to hockey-stick phenomena, the definition provided solid support of designing the game input which is the order quantity from the customer. The stimuli and effect of this phenomenon facilitated the instructional

design of the game, as well as address the importance of this research. The previous research and publications on cocoa-chocolate supply chain provided crucial information of constructing the game board and central mechanics for this educational game. Furthermore, this section provided the idea of designing the card drawing activity to simulate the US FDA test. The last section covered the great benefit that interactive study can bring to students. This provides a rationale for why a board game was chosen to deliver the knowledge related to the hockey-stick phenomenon. Furthermore, with the previous research on educational game design methods, a solid foundation was laid to facilitate the design of the game board and provided powerful support for constructing a methodology. The game evaluation method was used to support the validation process of the game designed in this research.

## CHAPTER 3. METHODOLOGY

### 3.1 Framework

This research combined both quantitative and qualitative methods to develop an educational board game, pilot test the game, test the finalized game design with undergraduate students and analyze the students' feedback. The main focus of this research was the game design. The newly designed chocolate game was modeled from the Beer Game designed by the MIT Sloan School of Management. The supply chain model used in the game was modified to represent key characteristics found in cocoa-chocolate supply chains. Additionally, the demand pattern for cocoa beans was modified to represent the hockey-stick phenomenon. Limited research on educational board game design was found. The design of the game followed the Ten Steps to Complex Learning Method (TSCLM) (Enfield, 2012). The game evaluation followed a summative evaluation method with combined expert evaluation and retrospective evaluation. The newly designed game was tested with undergraduate students majoring in Supply Chain Management Technology at Purdue University.

The research followed the process shown in Figure 3.1. The background research and literature review was used to confirm the research argument, determine the game design objective, and support the theoretical research. The actual design of the game included the design of the board game, pilot study of the game, expert review of the initial game design, game design revision and feedback for the modified

game from undergraduate students. The feedback of the students was collected through a retrospective survey; the results were analyzed evaluate the learning that occurred. Lastly, the conclusion and future research directions were documented.

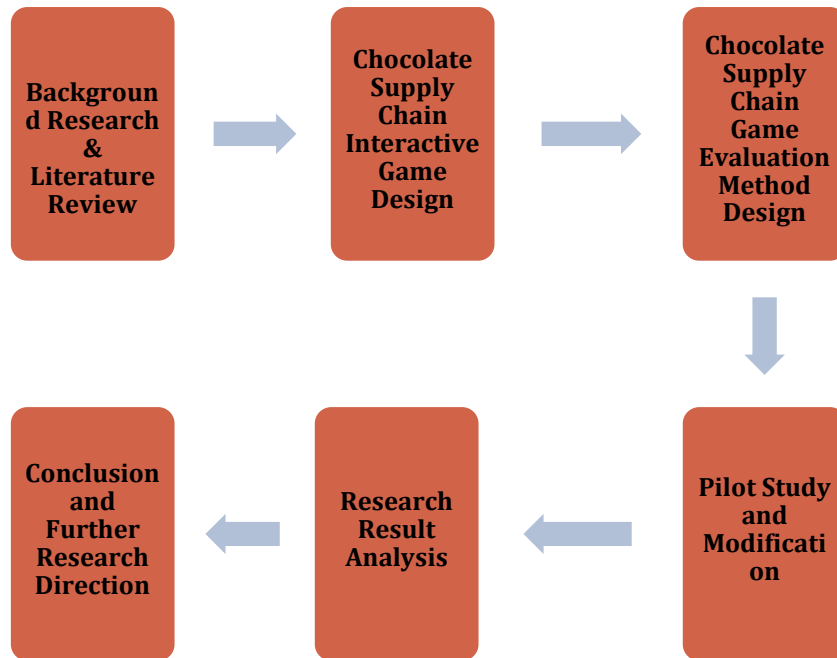


Figure 3.1 Process Map of Research Method

### 3.2 Game Design Method Modification

Within the limited choices for educational game design, TSCLM (Enfield, 2012), was chosen to model the design process in a systematic order. The method was not specifically for educational games and “steps are not intended to follow sequentially, but instead used in a flexible and interactive manner” (Enfield, 2012, p. 28). Table 3.1 lists the modified design steps and the resources for each step. The steps directly related to game design were followed and the steps related to cognitive and mental analysis were eliminated. Also the TSCLM was used only for instructional design process. The physical game design was adopted from Educational Board Game Design Method (EBGDM) (Salter, 2013). Both the TSCLM and



EBGDM models did not directly address game evaluation. Therefore, the revised model reflects the added steps necessary.

Table 3.1 Modified Design Steps

Source	Steps
EBGDM	1. Brainstorm an educational idea
TSCLM	2. Design and sequence learning tasks
EBGDM	3. Choose a central mechanic
EBGDM	4. Design system and pieces
TSCLM	5. Set performance objectives
TSCLM	6. Design supportive information
TSCLM	7. Analyze prerequisite knowledge
TSCLM	8. Design procedural information
Newly Added	9. Design the content of the feedback survey
EBGDM	10. Prototype and test play the game design

### 3.3 Cocoa-Chocolate Supply Chain Board Game Design

#### 1. Brainstorm an educational idea

The first step involved a brainstorming session to identify an educational idea that could facilitate students' learning ability for common supply chain knowledge. The idea needed to be designable into an educational game, and help with industry problems.

The hockey-stick demand pattern was added to be the supply chain game because of the widely occurrence of this problem in the industry. Implementing the hockey-stick demand pattern was designed into the input of the game. Specifically the

demand order quantities were modified to follow the hockey-stick pattern as shown in Figure 3.2.

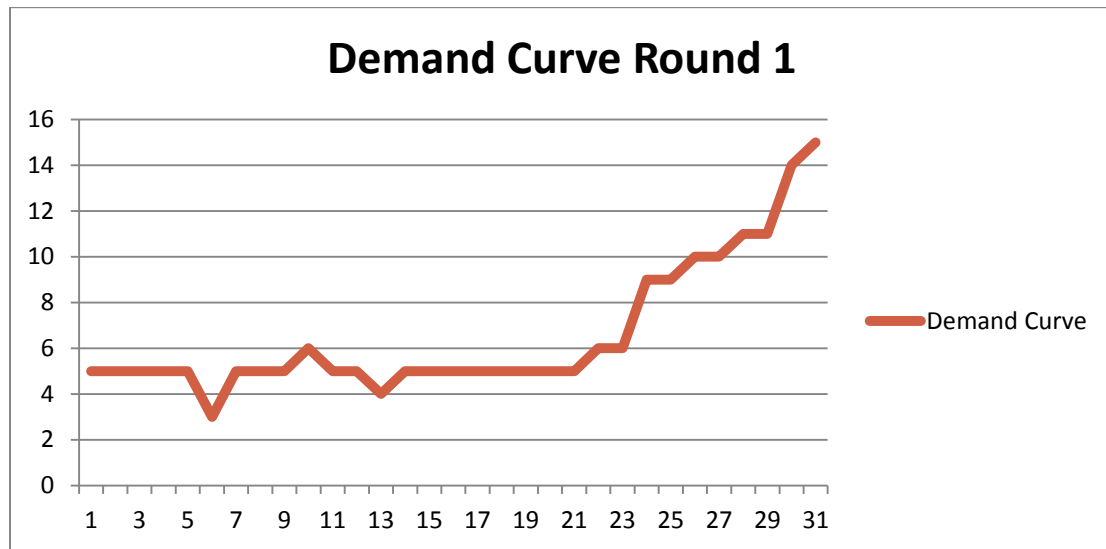


Figure 3.2 Demand Pattern for Round 1

## 2. Design and sequence learning tasks

The overall learning task of this game was to recognize the hockey-stick demand pattern, raise students' awareness of the phenomenon and develop their ability to strategize to compensate for the demand variability. The learning tasks order for the students were defined as:

- a) Realize the negative outcomes the hockey-stick phenomenon could cause
- b) Design strategies to reduce the negative effect brought by the hockey-stick phenomenon.
- c) Gain understanding of how to deal with communication delay and risks associate with importation quality check.

## 3. Choose a central mechanism

The central mechanism chosen was a revised Beer Game (MIT Sloan School of Management, 1985), which is an existing interactive supply chain board game. The

revisions included modeling the cocoa-chocolate supply chain, instead of beer. Cocoa-chocolate supply chain has higher demand over holiday season. This meant that demand for chocolate was higher in the first quarter and last quarter of the calendar year including Thanks Giving (November), Christmas (December), New Year (January) and Valentine's Day (February). The cocoa-chocolate supply chain had different international trade issues which complicated the game. Furthermore, chocolate is a popular consumer good and students are easily drawn to the game. Hence, the central mechanism of this game was a simplified model of the cocoa-chocolate supply chain.

The supply chain stake holders were unique due to the difference in the raw material importation countries. The selections of the key stake holders were selected from the literature review on cocoa-chocolate supply chain. Farmer, urban distributor, exporter, importer, manufacture, distributor, wholesaler and seller formed the supply chain structure for this game.

#### 4. Design system and pieces

In this step, the detailed game board design, input information design, game facilitation tool design, and initial game board set-up were developed.

##### Game Board Design

One game board was designed for use in multiple rounds of the game. The game board had four key components including the key supply chain stake holders, incoming order and placed order options, and two shipment delays. Black arrows on the board were chosen to indicate the order flow and red arrows were chosen to indicate the information flow. A sample game board was shown in Figure 3.3.

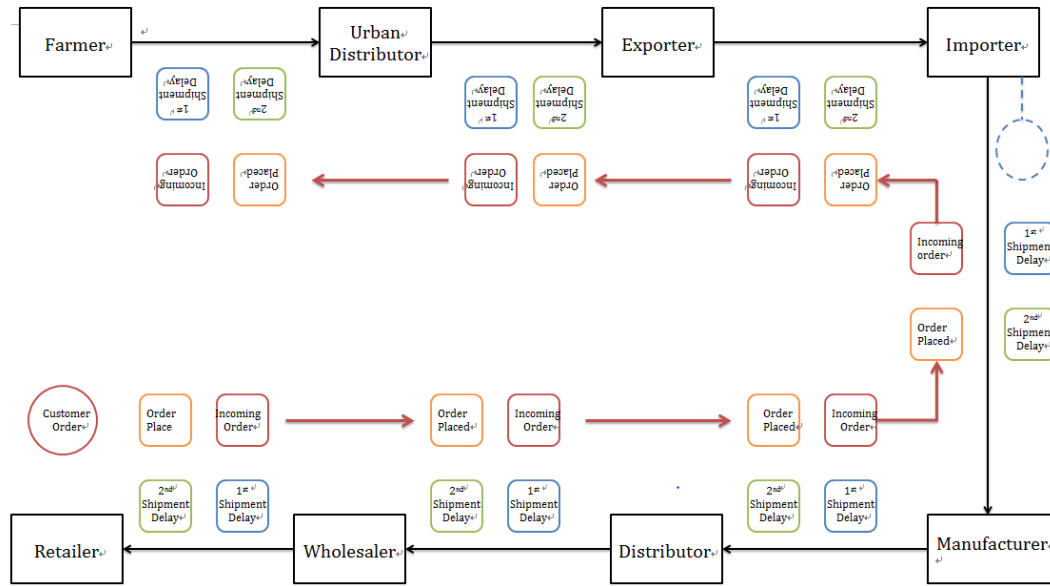


Figure 3.3 Game Board

### Input Information Design

The game was designed to have two rounds with 31 orders cycles placed by the customer each round. The customer demand pattern was designed to be a hockey-stick shape curve with one demand quantity for each cycle. The customer demand was restricted to between 1 to 20 units. The first three orders were designed to be 5 units for each cycle, so that the students have time to become familiar with the game rules and fulfill orders using the initial game set-up. The demand curve for rounds 1 and 2 have the same shape but slightly different number. According to the definition of the hockey-stick phenomenon, the hockey stick shape curve can occur repetitively during a fixed time period. The two rounds were simulating two fixed periods.

In the second round of the game, the information input included a quality check for FDA pesticide check was adding to the game. The FDA, there is an un-pass rate for the cocoa bean pesticide check; the un-pass rate for the designed game was 4.4%, which was the average number of the un-pass rate provided by the FDA (2008).

The students would draw a card from the importer stack, and the card would signify whether the coca bean passed the quality check.

#### Game Facilitation Tools Design

Notes – Each participant received a stack of notes to write and place their order for the upstream stakeholder in the supply chain.

Record Sheet – Each participant had a record sheet, this sheet were used to record the backlogs for each round, so their team could analyze their game performance.

Chips – The chips were used to simulate the chocolate and cocoa beans. During the game the players were able to move the chips to downstream sections; this was simulating the goods flow.

Input Information Cards – The orders placed by customers were on same sized cards; and the pesticide check results were also written on the same sized card.

#### Initial Game Set-up Design

The initial game set-up included some in-transit inventory and warehouse inventory and the quantity was enough to fulfill order for the first three rounds (Chen & Samroengraja, 2000). So, the initial in-transit inventory was designed to be 5 chips in all the shipment delays, the same as the first three customers' order. The inventory in the warehouse of the supply chain sections was 15 chips per warehouse; this was the stock for the total number of the first three customer orders.

#### 5. Set performance objectives

Round one of the game was designed to create confusion with little guidance from the instructor. The students played the game with no developed strategy, and the first round should be able to inspire students to seek better game strategies. After the

first round, with the debriefing information provided by the instructor, the students had more knowledge about the hockey- stick demand pattern. Hence round two of the game tested students' strategy of dealing with this demand, so the outcome of round two should be better than round one. Students' should be able to identify which part of their strategies improved the round results.

#### 6. Design supportive information

In the first session of the game, only game instruction was provided. Before the second session, the debriefing (After Action Review) provided the students with an evaluation of their actions during the game and supportive information on the hockey-stick phenomenon, including its definition and features.

##### After Round 1

A debriefing was provided after round one to help students analyze their action in Round One. The debriefing presentation a including describing hockey-stick demand pattern including the definition, effects and stimuli.

##### After Round 2

The debriefing goal was to help students analyze their strategies. Knowledge points including international trade, supply chain risks and how to reduce the effect of hockey-stick shape demand.

#### 7. Analyze prerequisite knowledge

This game addressed the supply chain performance under the influence of the hockey-stick phenomenon, and introduced the concept of the hockey-stick phenomenon to the students. The students need to have introductory knowledge of the

supply chain process or have relevant work experience, but have limited knowledge on hockey-stick phenomenon.

#### 8. Design procedural information

Just-in-time information was provided along the game. The game procedures mimicked the Beer Game procedure, with revision to align with the chocolate supply chain and unique demand pattern.

Each participant received a handout for each round describing play of the game. The information included an explanation of the game board, general operational instructions for all stake holders, separated instructions for each stake holder and helpful hints for successfully playing the game.

#### 9. Design the evaluation method

The evaluation method combined expert review and retrospective survey to test the reliability and effectiveness of the chocolate supply chain game. The evaluation process was shown in Figure 3.4.



Figure 3.4 Evaluation Process Mapping

#### Expert Review

Expert review was a sufficient tool to evaluate the clarity, accuracy, relevance, validity and appropriateness of the content (National Quality Council, 2009). The game design was presented to three educational gaming and interactive study subject

matter experts and asked to evaluate the game design process for its clarity, relevance of the content and appropriateness of the design. The experts selected should have strong experience in interactive study or educational game design for college level education, and willing to observe the game playing process at Munich, Germany.

### Retrospective Survey

The retrospective survey was one of the most effective tools for testing the design effectiveness without leaking game related information to students prior to the game. The students were asked to conduct the gaming activity without any prior knowledge of the game objectives. After the game was completed, students completed the survey through recalling their pre-game knowledge level of certain topics and concepts. The pre-test and post-test were admin after the game was completed. Descriptive data analysis was performed on the data collected (see Chapter 4.2); furthermore increase of the test score were used to analyze the effectiveness of the game.

### Survey Questions Design

The survey contained 6 questions. The questions were designed to evaluate the operational learning that occurred and whether the students learned the designated knowledge from the gaming process. Furthermore, the questions were designed to see how deep did students' knowledge of each point went to ensure that the students were not being distracted by the relatively less important points compared to the hockey-stick phenomenon. The survey questions designed followed the template (David, 2002). The survey the questions were modified to reflect the key concepts covered in the game debriefing material and fit the game objective. Hence, the students were



asked to rate their knowledge level or understanding of the basic concepts related to hockey-stick phenomenon, international trade, cocoa-chocolate supply chain and strategies to deal with hockey-stick phenomenon. A complete survey is shown in Appendix M.

#### 10. Pilot study and modification

The initial design of the game was tested through a pilot study, and the experts Dr. Edie Schmidt, Dr. Regena Scott and Dr. Helen McNally were invited to observe the process and provide feedback. The experts were selected from Purdue University – West Lafayette, they are experienced professors in educational game design and interactive study. All of them had experience on either designing educational board game or instructing an educational game to their students. The game was tested with 20 students from Munich University of Applied Science, located at Munich, Germany. The students were all non-native English speakers registered for a Supply Chain Management Course taught in English. All of the students had basic knowledge of Supply Chain Management and were able to communicate using English proficiently. The game testing took 180 minutes total.

#### Pilot Game Design

The pilot game design had two rounds, which required students to complete a series of tasks related to receiving orders, placing orders, sending goods and receiving goods. The game had 31 cycles for each round, and 8 students formed one group. The demand was pre-designed to be a hockey-stick shape curve.

The game board design followed the game board from the Beer Game. Instructors provided students with limited information related to the cocoa-chocolate

supply chain and a rough introduction to the game. Then, the students were required to complete the tasks according to their stakeholder instructions without communication among the group members. Then, the instructor debriefed round 1 and introduced students to round 2. In round 2, the students performed the same activities as round 1 except for the importer, who had to draw a card to determine whether the goods passed the US-FDA test. This round, the students were allowed to communicate every other cycle, and they were notified that the demand followed the hockey-stick shape. Detailed instructions were distributed to the students prior to the game start. After round 2 the instructor gave a debriefing to the students.

#### Expert Feedback

The experts pointed out three major problems and concerns they had regarding the game.

First, the game was not innovative enough. The experts could not differentiate the Coco-Chocolate Supply Chain Game and the Beer Game.

Secondly, the pre-game instructions and player guides were confusing to students and they got lost when they started playing the game. They did not understand the game rules. Also, the game time was too long, and the tasks for two rounds were too repetitive, frustrating the students.

Thirdly, the students did not have enough time to recall supply chain concepts knowledge. The students did not have time to process what they learned about the chocolate supply chain, and the game designed did not have enough relevance to the coco-chocolate supply chain.

#### Modifications

- The game structure was revised to have two sections. The first section was build-up the cocoa-chocolate supply chain. The students put the cards representing different facilities, products and transportation tools on to the pre-designed game board.
- The second section was similar to the initial game design; it was a simplified version of the Beer Game. The supply chain structures used for the game boards were more visualized and there were less chain stake holders.
- The order cycle was reduced from 31 cycles to 11 cycles to shorten the play time and decrease the repetitive tasks.
- The stake holder game instructions were written by role instead of distributed a general one for all the students.
- More variables such as shipment delay and quality check were added to the game, so each participant were asked to deal with different risks during the gaming process.

### 3.3.1 Modified Chocolate Supply Chain Board Game Design

After gathered the information from the experts, the game structure was modified to have two sections, and for section II there are two rounds as shown in Figure 3.3.

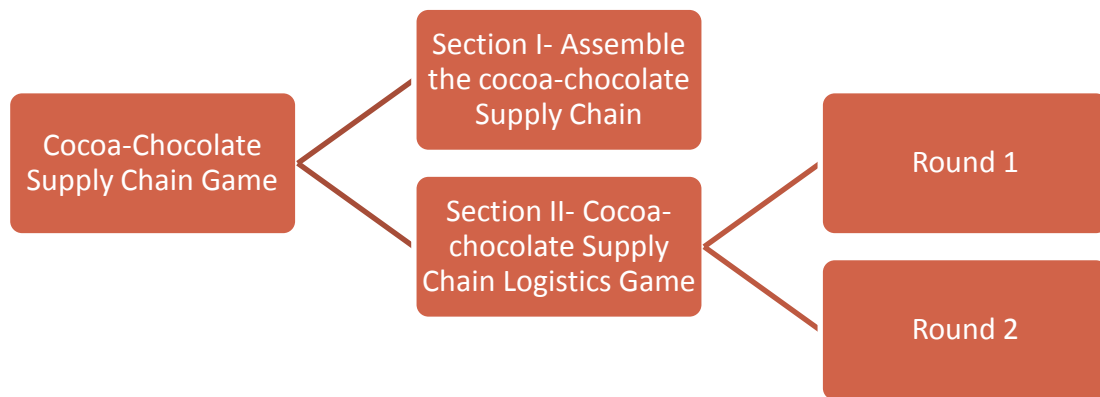


Figure 3.5 Modified Game Structure

The initial game design was modified using the same methodology as shown in Table 3.1.

#### 1. Brainstorm an educational idea

This modified game was not only designed to address the negative effect of Hockey-stick phenomenon but also get students familiar with the chocolate supply chain. The game was designed to have different sections and rounds to lead the students form strategies by themselves. The hockey-stick phenomenon was still implemented by designing the customer order quantity, however, the modified game design only have 11 customer orders for each round in the Cocoa-Chocolate Supply Chain Logistics Game.

#### 2. Design and sequence learning tasks

The overall learning task modified to help students understand the cocoa-chocolate supply chain process and raise the awareness of the negative effects by hockey-stick phenomenon.

Assemble Cocoa-Chocolate Supply Chain -Facilitated students to gain basic knowledge of cocoa-chocolate supply chain and recall common supply chain structures and functionality of each supply chain section.

Cocoa-Chocolate Supply Chain Logistics Game - Realized the negative effect caused by hockey-stick phenomenon and got familiar with the gaming procedure after played round 1. Got a deeper understanding of how to reduce the negative impact caused by hockey-stick phenomenon. Gained basic understanding about how to deal with communication delay, variance on shipment delay and import regulations after played round 2.

### 3. Choose a central mechanic

The selections of the key structures were mainly based on the literature review on Cocoa-Chocolate Supply Chain section 2.2.2. In this modified game design, the most commonly seen chain structure including farmer, urban distributor, exporter, importer, manufacture, distributor, wholesaler and seller was used to design the game board for Assemble the Cocoa-Chocolate Supply Chain.

The shortened structure of the cocoa-chocolate supply chain was picked out to form a game board for Cocoa- Chocolate Supply Chain Logistics Game, which including farmer, importer, manufacturer and retailer. These four roles were picked because each of them could involve the students with more activity and they were irreplaceable.

#### 4. Design system and pieces

##### Game Board Design

There were three game boards designed for this game. The game board for Assemble Cocoa-Chocolate Supply Chain was designed to have space for students to put the cards accordingly into the empty spaces for Chain Sections, Transportation Tools and Products as shown in Figure 4.2. For the Cocoa-Chocolate Supply Chain Logistics Game, two game boards were designed for the two different rounds. The game board has four key components including the key supply chain structure (pictures with role name on it), order operations including placed order (orange box), one shipment delay (green box) and given information feed (blue dashed line circle). There were slight differences between the two boards with the game board for Round 1 only having one information feed, which was the order from customer. The shipment delay was fixed to be one day in between each section. For Round 2, each role had a information feed, the person in charge of that working unit have to get information accordingly; and the shipment delay various between one or two days. The game board for Round 1 was shown in Figure 4.4, and the game board for Round 2 was shown in Figure 4.5.

##### Input Information Design

For Cocoa-Chocolate Supply Chain Logistics Game, each round had 11 orders placed by the customer. The customer order was designed to be a hockey-stick shape curve, in order to fit the purpose of the game. The first 2 orders were stable, so that the students could have a buffer time to get familiar with the operations and fulfill the orders with the initial game set-up. The demand curve for round 1 and 2 had the same

shape but slightly different number. The actual demand curve was shown in Figure 3.3

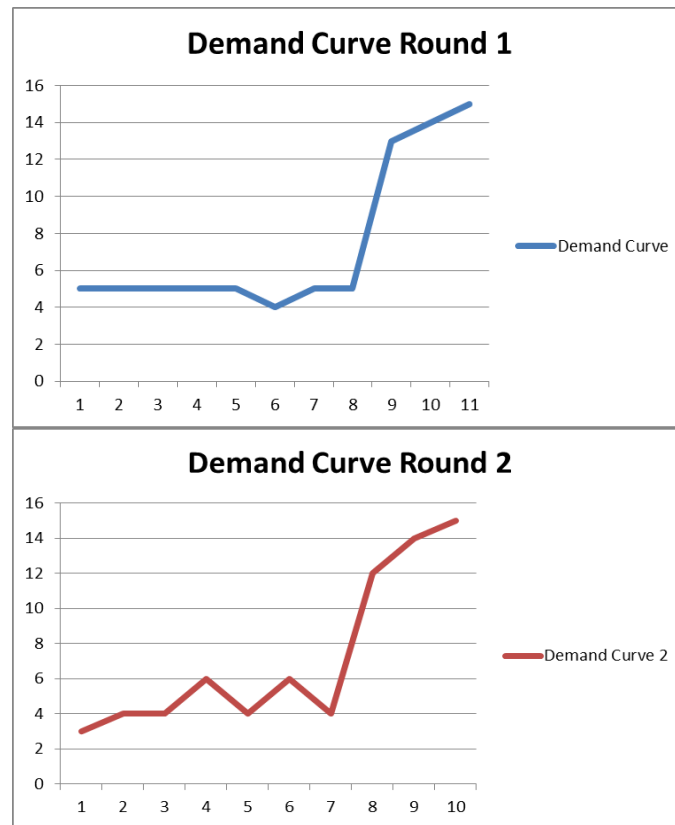


Figure 3.6 Demand curve for two rounds

In the second round of the game, the information input for FDA pesticide check is adding to the game. The un-pass rate still remained at 4.4% as the original game designed. A stack of card was laid at the importer section on the game board, so the participant could flip the card to decide if the cocoa beans meet the quality requirement or not. Also, there were input information for both farmer and manufacturer to determine whether the shipment delay was one or two days. This was used to simulate the unstable/unpredictable shipment delay in reality.

### Game Facilitation Tools Design

#### Section I

- Supply Chain Roles - A photo of each cocoa-chocolate supply chain role were cut into cards and distributed to the students
- Transportation Modes- the pictures of the transportation modes might involve in the good delivery process were cut into cards and distributed to students
- Products – the pictures of possible intermediate product for each chain sections were cut into cards.

## Section II

- Sticky Notes – Each participant got a stack of sticky notes to place order for the upstream section.
- Coffee Beans– The coffee beans were used to simulate the chocolate and cocoa beans. During the game the player were able to move the coffee beans to downstream sections, this was simulating the good flow.
- Input Information Cards – The orders placed by customer were write on same sized cards; The pesticide check result and shipment tools was written on the same sized card.

## Initial Game Set-up Design

The initial game set-up should include some in-transit inventory and warehouse inventory; the quantity should be enough to fulfill the order for the first several rounds. Since there were only 11 cycles for the second section of the game, the in-transit and warehouse inventory were set to fulfill the first day's demand only. In Round 1, the initial in-transit inventory was designed to be 5 coffee beans in all the shipment delays; this is the quantity for the first customer orders. The inventory in the warehouse of the supply chain sections is 5 coffee beans per warehouse; this was the



stock for the first customer order. In Round 2, the initial in-transit inventory was designed to be 3 coffee beans in all the shipment delays; this was the quantity for the first customer orders. The inventory in the warehouse of the supply chain sections was 3 coffee beans per warehouse; this is the stock for the first customer order.

#### 5. Set performance objectives

Assemble Cocoa-Chocolate Supply Chain Game was designed to be an easy warm-up section. Students should be able to feel relax and easily complete the tasks and this section was intended to help student recall some basic supply chain concepts so that this could provide them a easy start on the Cocoa- Chocolate Supply Chain Logistics Game. This section should be more involved. The students were pushed to think and act more. Round 1 of the Cocoa-Chocolate Supply Chain Logistics Game was provided very limited guidance and the game result were expected to be confusing whereas Round 2 was provided more guidance through the debriefing after Round 1, so a better result was expected and the students were expected to have more fun too.

#### 6. Design supportive information

The supportive information were designed to provide participants with basic information to complete the gaming tasks and debriefing them with the knowledge points that could help them reach the learning objectives. There were three main sections that supportive information will be provided:

##### Before Section One

Before play the game, an interactive presentation were provided to cover the background knowledge of cocoa-chocolate industry, and some basic knowledge of

the supply chain process involved in this industry. Furthermore, policy related issues were covered as well. In this way, the participants got some basic information to perform the required tasks and achieve the learning goal of smooth out the initial knowledge base difference.

#### After Section I Before Section II Round 1

A debriefing was provided after section one to help students recall some of the basic knowledge related to supply chain including the different sections and their functions within the supply chain. Also, the instructor provided them with more information about cocoa-chocolate supply chain. Then a set of slides was used to introduce students with the second section of the game.

#### After Section II Round 1

The debriefing was helping students to analyze their results and performance. A short presentation was given to address the occurrence of hockey-stick phenomenon including the definition, effects, stimuli, etc. Also, introduce students to the second round of the game. The set of Powerpoint presentation helped the participants to get basic knowledge and awareness of the hockey-stick demand pattern to facilitate the students make more strategic decisions in the next round.

#### After Section II Round 2

The debriefing was helping students to analyze their results and performance. A short presentation was given to address the strategies of dealing with hockey-stick demand pattern, quality check, shipment delay variance.

7. Analyze prerequisite knowledge

This game required participant have basic knowledge of overall supply chain process or have some practical experience in supply chain related industry. In the test case of the finalized game design, students were required to register for Production Planning course.

#### 8. Design procedural information

Since Assemble the Cocoa-Chocolate Supply Chain Game was designed to be very straight forward, so there was not procedural information needed, the instruction of how to play the game was included in the Powerpoint slides prior to play the game. For Cocoa-Chocolate Supply Chain Logistics Game, each participant got a handout for each round describing how to participate in the game. The information including explanation of the game board, general operation instruction for all roles, separated instruction for special roles and notes for successfully participating in the game.

## CHAPTER 4. FINDINGS, RESULTS AND DISCUSSION

This section describes the finalized design of cocoa-chocolate supply chain educational game, and analyzes the results of the survey evaluation. Furthermore, this section provides future recommendations for game modification and assessment.

### 4.1 Finalized Cocoa-Chocolate Supply Chain Game

The finalized game design involved two design perspectives: board game design and instructional material design.

As shown in Figure 4.1, the game was designed in two distinct rounds to achieve the desired learning objectives.

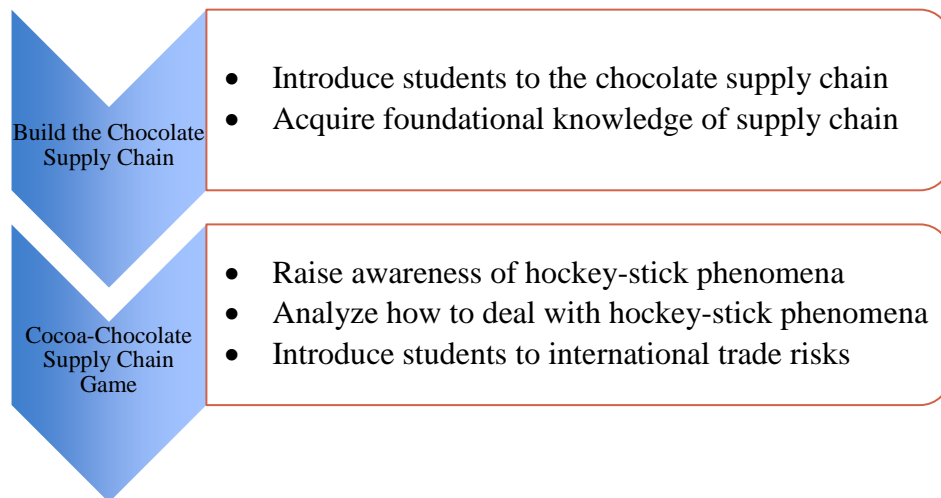


Figure 4.1 Finalized Game Design Objective

#### 4.1.1 Section I- Build the Chocolate Supply Chain

The students worked in groups of 5 and each group had a game board as shown in Figure 4.2. They were provided with game cards (Appendix A) that contained pictures of different supply chain roles, transportation modes, and finished products for each cocoa-chocolate supply chain stakeholder. Students worked with their groups and were asked to place the cards into position according to their knowledge, to form a complete cocoa-chocolate supply chain.

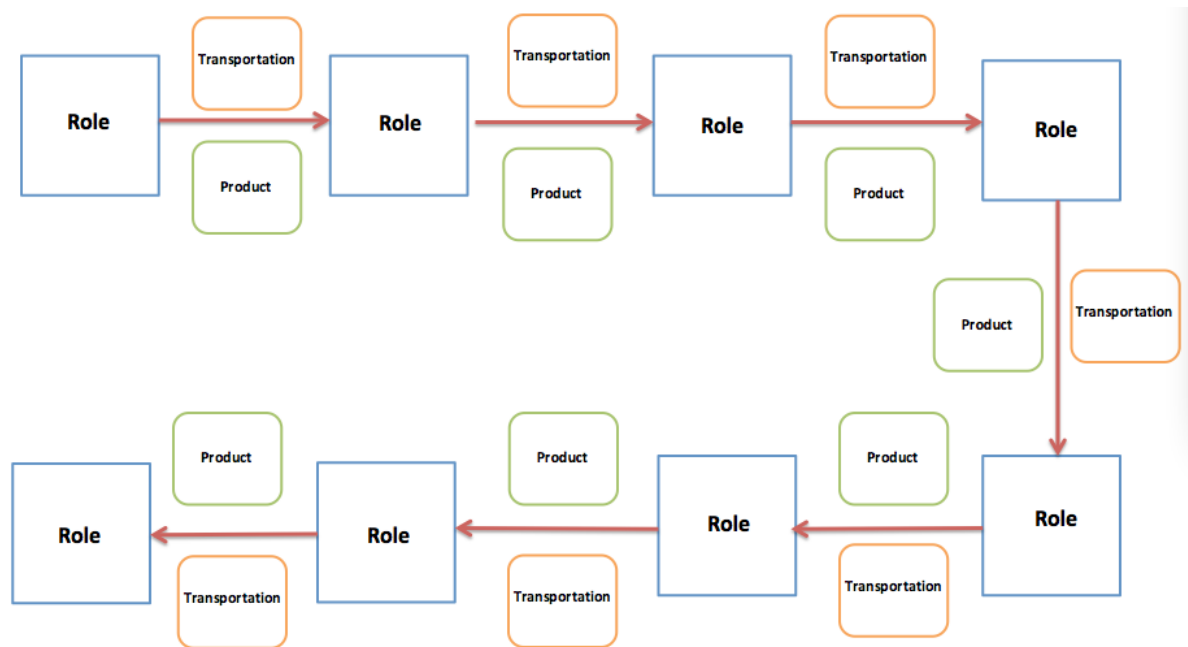


Figure 4.2 Game Board for Section I

The instructor provided three sets of instructional material to facilitate students' learning experience:

- 1) Prezi presentation titled *Chocolate Supply Chain- The Sweetest Industry* (shown in Appendix B), which covered the almond chocolate's raw material processing, raw material delivery, and manufacturing processes. This provided students with background knowledge of the chocolate supply chain.

This presentation was a course project from Global Supply Chain Management offered by Purdue University-West Lafayette Technology Innovation and Leadership department. The project was completed by Anran Wang, Ang Li and Ye Zhao.

- 2) Powerpoint slides titled *Cocoa-Chocolate Supply Chain- Section I Introduction* (shown in Appendix C) covered detailed information about the supply chain structure of almond chocolate and the game instructions for this section.
- 3) Powerpoint slides titled *Cocoa-Chocolate Supply Chain- Section I Debriefing* (shown in Appendix D) summarized the cocoa-chocolate supply chain structure, a brief recap of different supply chain section functions, and chain structures for international trade products.

The instructional process mapping was shown in Figure 4.3. The instructor provided students with the *Chocolate Supply Chain- the Sweetest Industry* presentation, then showed students the slides of *Cocoa-Chocolate Supply Chain- Section I Introduction*. These instructional materials provided the students with background information to efficiently perform the required activities for Assemble the Cocoa- Chocolate Supply Chain Game. Then, the students were asked to assemble their own cocoa-chocolate supply chain by putting the supply chain stakeholder, transportation mode and finished products on the game board shown on Figure 4.2 accordingly. After the activity was completed, the instructor went through the *Cocoa-Chocolate Supply Chain- Section I Debriefing*.

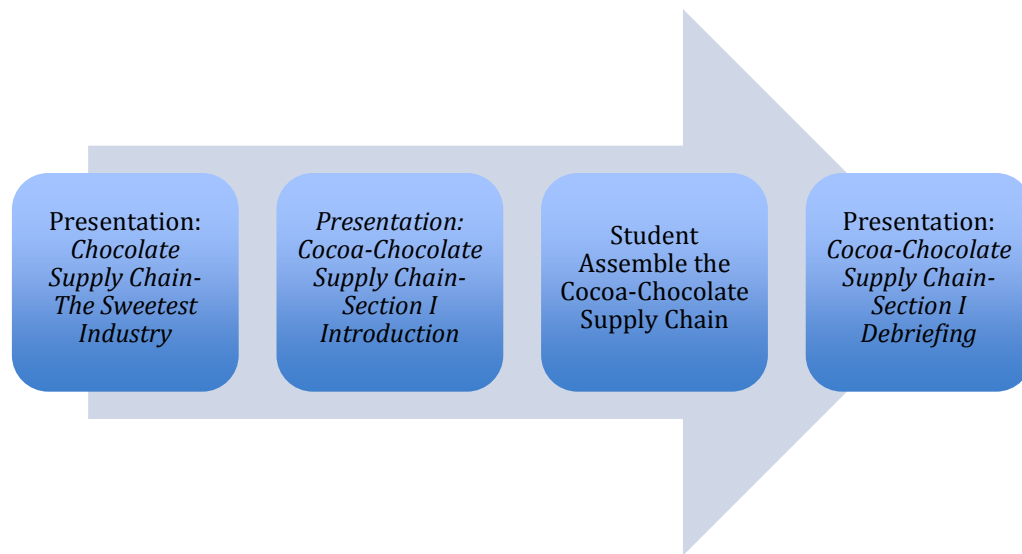


Figure 4.3 Process Mapping for Assemble Cocoa-Chocolate Supply Chain Game

#### 4.1.2 Section II- The Cocoa-Chocolate Supply Chain Game

In this section of the game, the students worked in groups of five. Each participant was assigned a stakeholder to perform corresponding to a stakeholder functions. The five roles were: Retailer, Manufacturer, Importer, Farmer and Pace Keeper. The game included a game board for each round of this section; sticky notes were used as order slips, coffee beans represented the goods and additional gaming information including transportation modes, quality check and customer orders was provided by small cards.

##### Round 1

The game board shown in Figure 4.4 was the working space. The game board initialization guide for instructors is attached in Appendix E. The students were instructed to perform specific activities according to their detailed game instruction (shown in Appendix F).

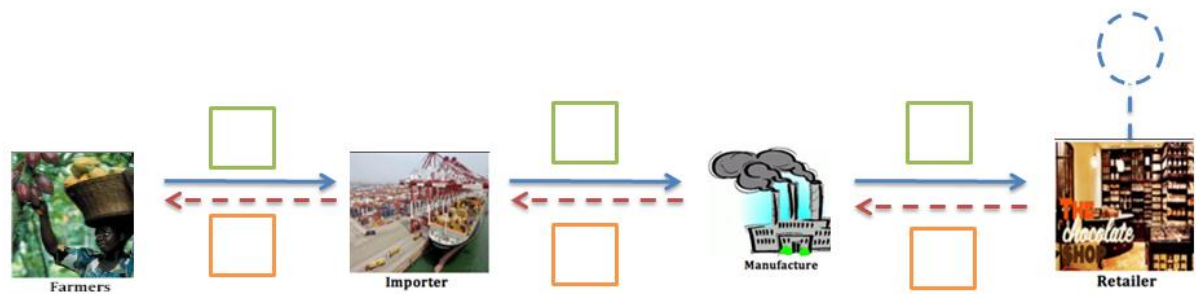


Figure 4.4 Game Board for Cocoa-Chocolate Supply Chain Game Round I

Retailer- The retailer was in charge of receiving the order from customer, and placing the exact order to the manufacturer; In addition, the ‘Retailer role was expected to receive goods delivery from ‘Manufacturer’ and send the goods to the customer to fulfill the demand.

Manufacturer- The ‘Manufacturer’ was in charge of placing an order to the importer, receiving order from the ‘Retailer’, receiving goods from the ‘Importer’, and fulfilling the ‘Retailer’s’ order.

Importer- The ‘Importer’ was in charge of placing an order to the ‘Farmer’, receiving an order from the ‘Manufacturer’, receiving goods from the ‘Farmer’ and filling the ‘Manufacturer’s’ order.

Farmer- The ‘Farmer’ was given an unlimited raw material supply, in addition to being in charge of receiving orders from the ‘Importer’ and fulfilling the order to the ‘Importer’.

The ‘Retailer’ received the customer order from the blue dashed line circle shown in Figure 4.4. There are 11 orders in total with the demand quantity being constantly small for the first 8 orders then increased to a very high quantity for the



last 3 orders, which formed a hockey-stick shape curve. There was no communication allowed for the first round, with the students experiencing hockey-stick phenomena without realizing.

### Round 2

The game board shown in Figure 4.5 was the working space. The game board initialization guide for instructors is attached in Appendix G. The students performed similar activities to Round 1; however in this round each role was asked to draw a card that could influence their supply chain performance. The detailed game instructions for each role are shown in Appendix H.

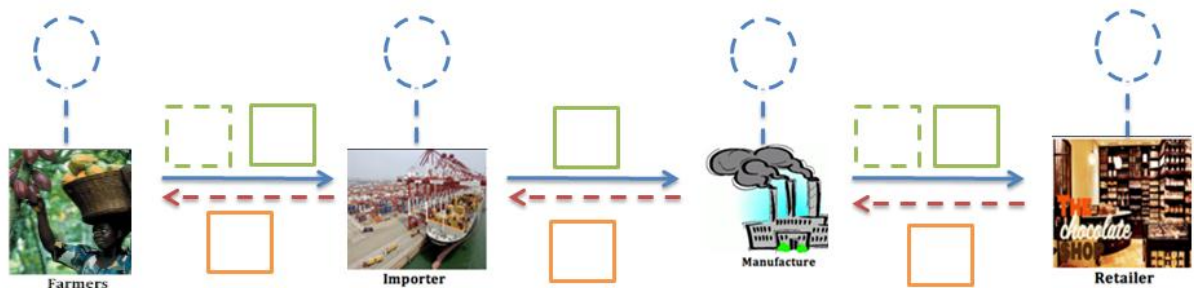


Figure 4.5 Game Board for Cocoa-Chocolate Supply Chain Game Round II

Since the students performed similar functions as Round 1, however, the card drawing section was added to the Farmer, Importer and Manufacturer roles. The Importer was instructed to draw a card from the blue dashed-line circle to decide whether the goods could pass the US-FDA quality check. If the good did not pass the test, the importer needed to empty the whole warehouse. If the product passed the test, the importer could send the good to the customer. The Manufacturer and Farmer drew a card to determine the transportation tool and the shipment delay, respectively.

If they drew the transportation tool representing two shipment delays, the students needed to place the goods into the dashed green square first, and then move the good into the regular green solid line box during the next game cycle. If they draw the card with one shipment delay, they were able to directly put the goods into the solid green box.

In this round, the students were given a chance to communicate every other round, which simulated the limited communication for international trade. The demand quantity was different from the previous round, but still followed the hockey-stick shape curve. The Retailer was allowed to bundle their purchase, they may pre-order the goods they need for the next several rounds.

#### Instructional Information

In this section of the game instructional information was provided using Powerpoint slides.

- 1) *Cocoa-Chocolate Supply Chain- Section II Round 1 Introduction* (as shown in Appendix I). This set of slides covered supply chain concepts and also an overview of the game board and student instructions.
- 2) *Cocoa-Chocolate Supply Chain- Section II Round 1 Debriefing* (as shown in Appendix J) debriefed the game by covering hockey-stick phenomena's definition, stimuli and possible solutions. Furthermore, the instructor led students to discuss more about their group strategies of dealing with hockey-stick phenomena for next round.
- 3) *Cocoa-Chocolate Supply Chain- Section II Round 2 Debriefing* (as shown in Appendix K) *debriefed* introduction of the difference between the second and first

round of the game was given to the students by the end of this presentation slides.

After the second round of the game, the instructor debriefed the game with solutions for hockey-stick phenomena, international trade, and solutions to shipment delay variance.

A process map for the Cocoa-Chocolate Supply Chain Distribution Game was shown in Figure 4.6.

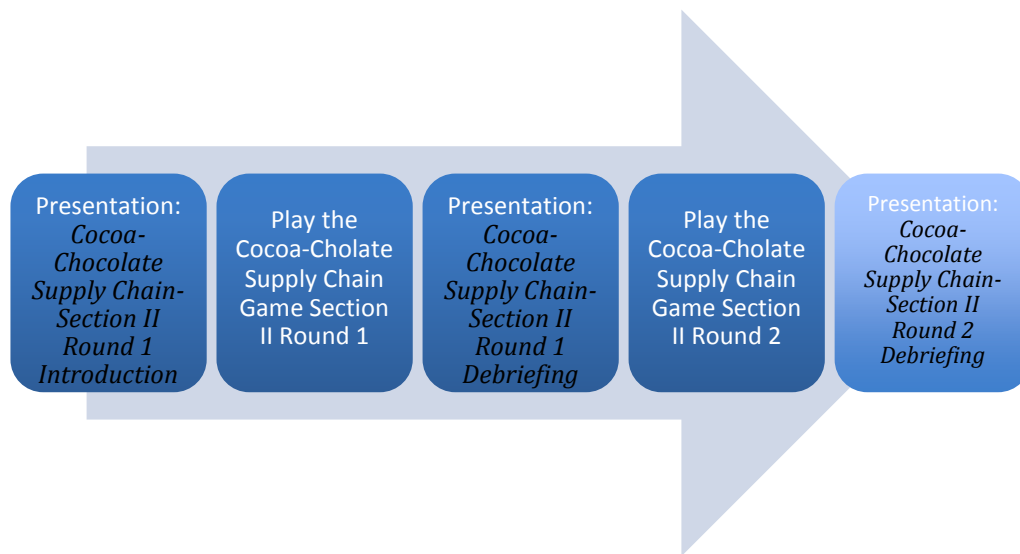


Figure 4.6 Process Mapping for Game Section II

Furthermore, in order to help the instructor set-up the game, a set-up procedure was provided in Appendix L.

## 4.2 Game Evaluation Process and Results

### 4.2.1 Game Evaluation Process

The retrospective survey of the cocoa-chocolate supply chain game was distributed among the 32 game students who were students of Purdue University-West Lafayette College of Technology. The students were registered students for IT442 Production Planning instructed by Dr. Edie Schmidt. The test took place in two different sections for this course's lab. The first section had 17 students, and the

second section had 15 students. However, both sections were overseen by the same instructor, utilizing the same instruction process and content. An overview of the game evaluation process is shown in Figure 4.7. The Prezi presentation of the supply chain and manufacturing process of almond chocolate was covered by the lab instructor to help students understand more about the chocolate manufacturing process and raw material delivery. Then, the lab instructor provided students with an introduction for the first section of the game, including the key points of the Prezi presentation, gaming content, gaming instruction and group formation. The students from the first lab session were divided into 3 groups within which two groups had 6 people and one group had 5 people. After they built the cocoa-chocolate supply chain the instructor debriefed the first section of the game, provided students with basic supply chain section functions and supply chain process. Then, a detailed instruction about how to play the second section of the game was provided by the instructor through the PowerPoint slides. Students received a detailed instruction for each of stakeholder on how to play the game step by step. The instructor walked students through the first cycle of their tasks by reading the manufacturer's instruction aloud, and watched as the students complete each step as directed. Then the Pace Keeper began his task and each group started playing on their group's game board. After the first round of the Cocoa-Chocolate Supply Chain Logistics Game, the instructor debriefed the students covering the hockey-stick phenomena, international trade, and importance of communication. Then, the instructor pointed out the difference between the first round and second round of the game and asked students to start the second round gaming. After the game was finished, the instructor provided them with

another debriefing covering the international trade, risks, and shipment delay variance. At the end of the game, the students were asked to complete the retrospective survey online through Qualtrics within 24 hours of their completion. This ensured the survey accuracy and the freshness of the students' memory. The survey included six questions, and used a retrospective approach. The survey questions accessed the students' understanding of hockey-stick phenomena, cocoa-chocolate supply chain, international trade, importance of communication, and willingness of participating in an educational game as shown in Table 4.1.

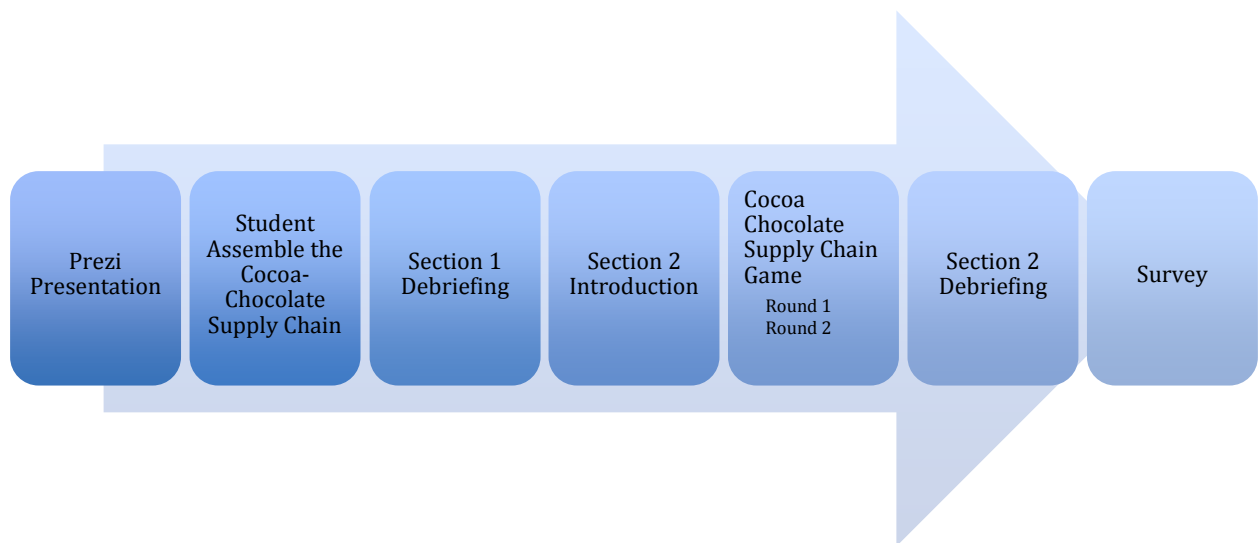


Figure 4.7 Game Instruction Process

Table 4.1 Retrospective Survey Questions

Number	Question
1	Knowledge of basic concepts related to supply chain
2	Familiarity with cocoa-chocolate supply chain
3	Understanding of the key concepts related to Hockey-Stick Phenomenon

4	Knowledge of the Hockey-Stick Phenomenon
5	Knowledge of the difference between international trade and domestic trade
6	Willingness to participate in an educational game

#### 4.2.2 Survey Results

The survey results were analyzed using Excel and SPSS to assess the validity and educational effect of the game. The data collected was analyzed using Descriptive Analysis, frequency/histogram analysis, and Whisker-Box Plots.

The survey results are shown in Table 4.1. Since the participants were students from an advanced undergraduate Supply Chain major course, they all were expected to have a relevant level of supply chain knowledge. Responses from the first survey question showed that the game helped student enhanced their basic supply chain knowledge as the mean value of the knowledge level increased from 5.84 to 7.5. In addition, the standard deviation decreased, which suggests that the game helped the instructor smooth out differences across their basic knowledge levels, so this could help the instructor to control the course pace better. Problems 2-4 were focused on the key subjects of this game design and evaluated whether the game was able to achieve the goal of enhancing students' understanding of cocoa-chocolate supply chain and hockey-stick phenomena or not. The results showed that the students' knowledge of those two key subjects increased to a statistically significant degree, and most of them reached an understanding score of either 7 or 8. This showed that the game design successfully addressed the key study objects of this educational game design. Question 5 was intended to evaluate students'

understanding of the difference between international trade and domestic trade, however, this is also making sure the portion of these type of side knowledge doesn't distract the major intention of this game. The results successfully indicated that the students did acquire a better understanding of the difference between international and domestic trade, and the increase of the score was very limited compare to the mean score increment of the questions related to hockey-stick phenomena and coca-chocolate supply chain. In addition, the difference between the score showed that the content distribution satisfied the design goal of introducing students' with some other concepts or risks related to supply chain without distracting students from the major learning objects. The last question was designed to evaluated students' willingness to participate in the educational game, the mean score slightly increased, alongside a moderately decreased variance; This suggests that this educational game did not frustrate students, and made a good impression on the students. This implies that, from a design perspective, the game process and content appeal to the students.

Table 4.2 Survey Analysis Results

<b>Cocoa-Chocolate Survey Results</b>						
<b>Question</b>	<b>Period</b>	<b>Mean</b>	<b>Median</b>	<b>Mode</b>	<b>Standard Deviation</b>	<b>Variance</b>
<b>1. Knowledge of basic concepts related to supply chain</b>	Before	5.84	6	6	1.63	2.65
	After	7.5	7.5	7	0.76	0.58
<b>2. Familiarity with cocoa-chocolate supply chain</b>	Before	3.59	3	3	2.03	4.12
	After	7.18	7	8	0.96	0.93
<b>3. Understanding of the key concepts related to Hockey Stick Phenomena</b>	Before	3.06	2	1	2.31	5.35
	After	6.63	7	8	1.81	3.28
<b>4. Knowledge of Hockey-Stick Phenomena (how to deal with it, stimuli and etc)</b>	Before	2.91	2	1	1.99	3.96
	After	6.19	6.5	7	1.55	2.41
<b>5. Knowledge of the difference between international trade and domestic trade</b>	Before	5.66	6	7	1.62	2.61
	After	7	7	8	1.11	1.23
<b>6. Willingness to participate in an educational game</b>	Before	7.34	7.5	9	1.77	3.14
	After	7.96	8	9	1.3	1.75

In order to have a better view of the data trends, Figure 4.8 contains a histogram for each question, from which the frequency of each score can be seen clearly. To further complement the histogram, in Table 4.2, the skewness and Kurtosis were listed. These two factors described the data shape in a quantitative way. ‘skewness’ measures in which direction the data has a longer tail, and Kurtosis measured how flat/steep the curve.



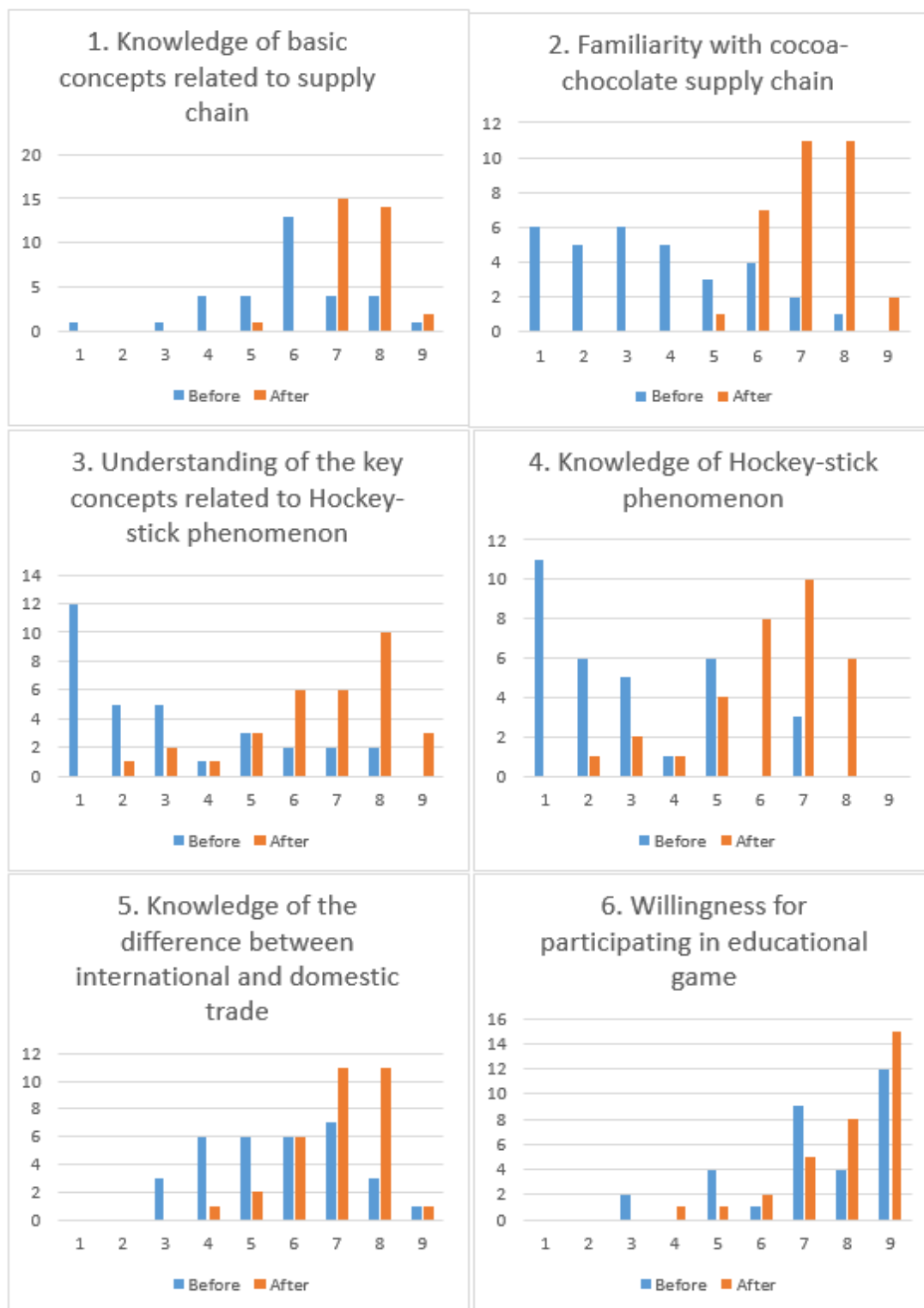


Figure 4.8 Histogram for Each Question

Table 4.3 Data Trend Analysis

Category	Q1		Q2		Q3		Q4		Q5		Q6	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
<b>Kurtosis</b>	1.46	2.61	-0.78	-0.46	-0.46	0.35	-0.54	0.81	-0.84	0.49	0.38	1.74
<b>Skewness</b>	-0.69	-0.70	0.42	-0.17	0.90	-0.93	0.79	-1.05	0.07	-0.76	-1.01	-1.42

Although the data appears to be accurate and can facilitate the validation of the game design, a certain amount of potential bias and uncertainty should still be taken into consideration. There are three major factors that might influence the data accuracy:

- (1) The survey results were based on self-assessment, so the data collected might not be very subjective. There exists a potential for under- and overestimation.
- (2) The survey was retrospective, so the students were required to recall their feelings after they played the game and, although all data was collected with 24 hours after they completed the game, there still might have been memory shifts.
- (3) The students of this game shared similar educational backgrounds, and the number of students was less than ideal. This might have reduced the reliability and representativeness of the data collected.

These factors can be adjusted in future studies with more students and better testing process, which will be discussed in the recommendation section of this paper.

## CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Conclusions

The purpose of this research was to design, construct and test an educational board game to fill a gap associated with the research and teaching of the hockey-stick phenomenon in supply chain education and training programs. Cocoa-chocolate supply chain was chosen to be the central mechanism and the design was inspired by the Beer Distribution Game developed by MIT Sloan School of Management.

The research provided a validated cocoa-chocolate supply chain educational board game as a final product. The initial game designed was not what the researcher expected; modifications were made to ensure the fun and educational effect of the game design. The game design was validated by the retrospective survey by accessing the participants' knowledge level of hockey-stick demand pattern, international trade, awareness of the importance of communication and willingness to participate in an educational game before and after participated in the Cocoa-Chocolate Supply Chain Educational Game. The survey results showed an obvious increase in the knowledge points that intended to be addressed by this game. Furthermore, the proportion of different knowledge points in the game was well-designed. So the students majorly focused on the learning of the hockey-stick demand pattern compare to the other points. The game was successfully designed to maintain the students' interests in

participating in an educational game. All the instructional and physical gaming materials are attached with this thesis to facilitate the future adoption of the game.

The research evaluated various board game design methods and modified the selected TSCLM and EBGDM methods into a more systematic approach as shown in Table 5.1. This addressed a need to conduct more research in the area of game design methodology. It also can help college level supply chain education to facilitate students' learning about hockey-stick phenomenon.

Table 5.1 Modified Educational Game Design Method

1. Brainstorm an educational idea	6. Design supportive information
2. Design and sequence learning tasks	7. Analyze prerequisite knowledge
3. Choose a central mechanic	8. Design procedural information
4. Design system and pieces	9. Design the content of the feedback survey
5. Set performance objectives	10. Prototype and test play the game design

Compared to the previous educational game design, this research have two key innovative points that could be adopted by the future research. First, the educational board game design method could be applied to future game design. It was a more linear and easy to follow procedure. Second, the use of retrospective survey provided a more reasonable way of validating the educational game design due to its characteristics of without leaking the gaming purpose prior the gaming process.

## 5.2 Recommendations

### Game Testing

Given time constraints, only very limited sample of students served as subjects for the game designed. In the future, larger samples should be used. The pilot study of the designed game was conducted in a different country and the students were from different cultural background, which resulted in a gaming experience seems to be different from the tests run at Purdue University. Future samples should continue to evaluate the impact of cultural background, educational background, and other demographic factors. Also, in order to maximize the accuracy of the retrospective survey results, the survey should be distributed to the student immediately after the game completed.

### Future Game Design

The research could be extended to design a Cocoa-Chocolate Supply Chain computer-based game, so that the set-up time of the board game can be eliminated, and the computer based game could serve more students at the same time. Furthermore, the game could be modified into games that fit different age groups. The current game design best suits the college level students; however, by modifying the game make it easier, it could be used to help high school or even younger age groups get to know what a supply chain is; Or, it could tailored or made more complex to fit a company's training program.

### Future Research Direction

Comparing the impact of culture among participants educational would be an interesting line of research due to the difference of educational systems, learning habits, and the educational gaming might have different impact on students. It would be useful to understand this to improve game development and the effectiveness of educational approaches.

Furthermore, the educational gaming's influence can be different because of age groups. Future research could be focus on how the gaming could impact elementary, high school, university students differently.

In addition, the research could gear towards corporate applications and trainings for the designed game as well as how to select the concepts that could be gamified within supply chain.

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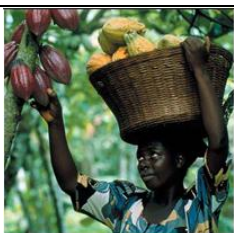





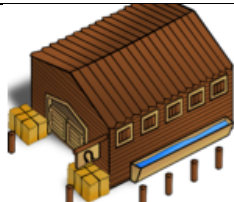










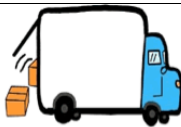

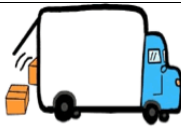



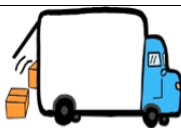
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## APPENDICES

## Appendix A – Game Cards for Educational Game Section I

Supply Chain Sections	
 <p><b>Farmers</b></p>	 <p><b>Local Processor</b></p>
 <p><b>Exporter</b></p>	 <p><b>Importer</b></p>
 <p><b>Manufacture</b></p>	 <p><b>Distributor</b></p>
 <p><b>Wholesaler</b></p>	 <p><b>Retailer</b></p>

Products and Transportation Tools	
 <p>Cocoa Pods</p>	 <p>Intermediate Products</p>
 <p>Intermediate Products</p>	 <p>Intermediate Products</p>
 <p>Chocolate Bar</p>	 <p>Chocolate Bar</p>
 <p>Chocolate Bar</p>	 <p>Truck</p>
 <p>Tractor</p>	 <p>Truck</p>
 <p>Cargo Ship</p>	 <p>Truck</p>
 <p>Truck</p>	 <p>Truck</p>

## Appendix B    Prezi Presentation: Cocoa-Chocolate Supply Chain – the Sweetest Industry

The link to the Prezi presentation is

[http://prezi.com/rcfmr9gysrxk/?utm\\_campaign=share&utm\\_medium=copy](http://prezi.com/rcfmr9gysrxk/?utm_campaign=share&utm_medium=copy)

Appendix C Cocoa-Chocolate Supply Chain Educational Game Section I  
Introduction

## Cocoa-Chocolate Supply Chain Educational Game

After hearing about the story, let's start our  
journey!

### Overview

- Pre-Game Instruction
- First section of gaming
- First section debriefing
- Second section of gaming
- Second section debriefing
- Survey

## Pre-Game Instruction

### Section I- Assemble the Supply Chain

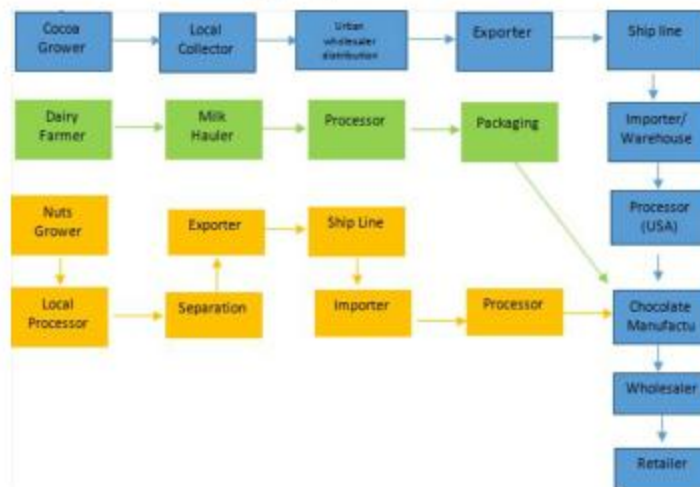
#### Almond Chocolate Raw Material

- Almond
- Dairy Product
- Cocoa Beans

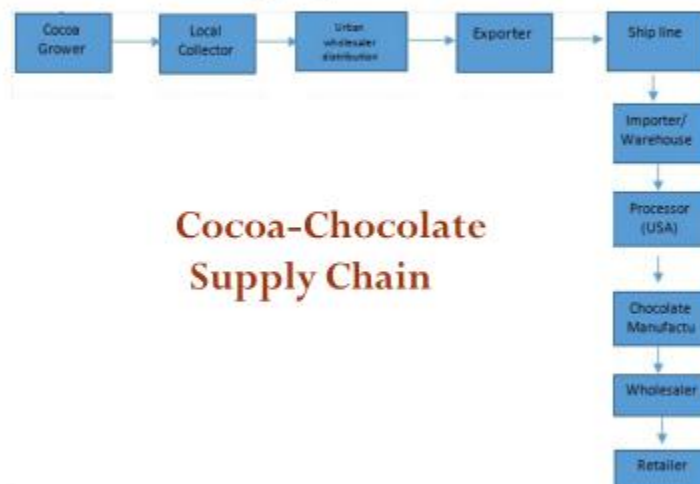




## General Supply Chain Overview



## General Supply Chain Overview



### Cocoa-Chocolate Supply Chain

## Introduction

- **Participants:** Group of five
- **Time:** 10 minutes
- **Tools:** Game board, Chain Section Cards, Transportation Card, Product Cards
- **Goal:**
  - Get familiar with the cocoa-chocolate supply chain.
  - Use the information provided in the previous presentation to assemble your supply chain

## Instruction

- In this section of the game, you will need to assemble the cocoa-chocolate supply chain
- Please put the chain section card in the blue box, the transportation tools in the orange box and the products in the green box.
- You can determine the sequence of the chain sections according to the information from the presentation or the logical analysis of your group

Appendix D Cocoa-Chocolate Supply Chain Educational Game Section I  
Debriefing

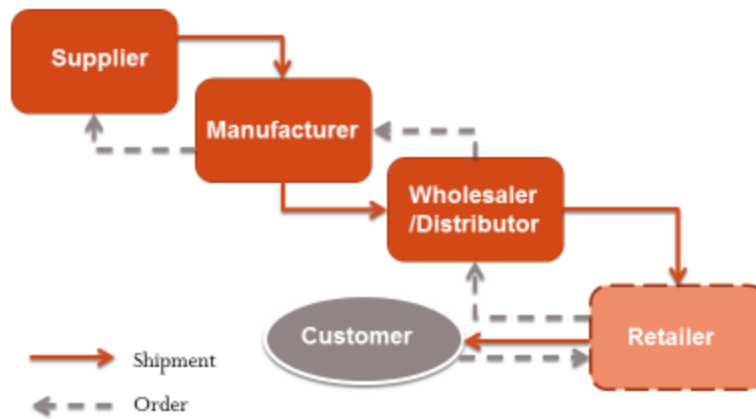
## Cocoa-Chocolate Supply Chain Educational Game

### Section I Debriefing

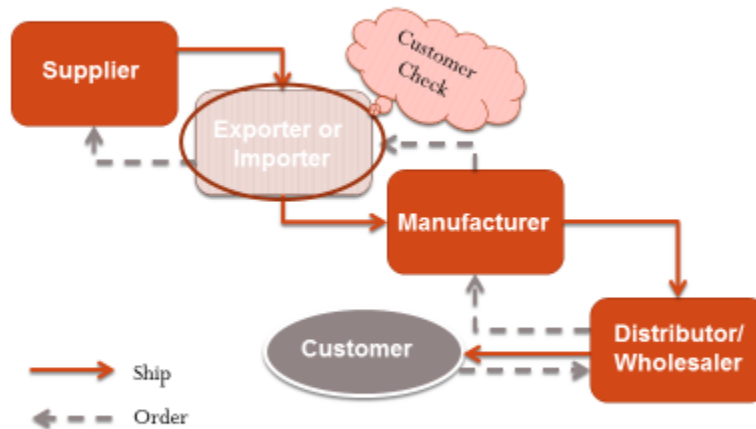
### Overview

- Tell me how did your group assembled your current supply chain
- What do you think is some key sections or irreplaceable sections in the supply chain you assembled?

## General Supply Chain Process



## International Supply Chain Process



## Function of Supply Chain Sectors

- **Warehouse** – Serve as a buffer between production and demand. Should not backlog or have too much inventory on hand
- **Supplier**-A party that supplies good or service
- **Manufacture**-An entity convert raw materials into desirable product or goods
- **Distributor**- An entity that buys noncompeting products, warehouse them and resells them to retailers or direct end users
- **Wholesaler**-Person or firm that buys large quantity of goods from various producers or vendors, warehouses them, and resells to retailers. Wholesalers who carry only non-competing goods or lines are called distributors.

## Cocoa-Chocolate Supply Chain



## Rate Your Performance

- What are the differences between the answer and your supply chain? Why they are different?
- What are some difficulties incurred while assembling the supply chain?

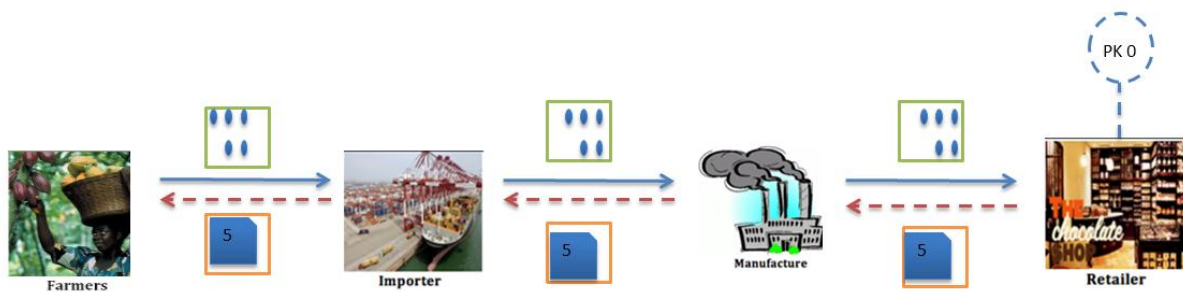
## Appendix E Cocoa-Chocolate Supply Chain Educational Game Section II Round

### Board Initialization

The board initialization will need coffee beans, which will serve as the good. The quantity and position for putting the beans is shown on the game board below. The order slip is placed facing down on the indicated position shown below. And the quantity on the order slip is shown on the game board initialization diagram below.

In addition, the instructor need to prepare enough paper for the group to place order.

Also, the instruction (see Appendix 4F) for playing the game need to distribute to the participants prior the game start.



The instructor need to put 5 coffee beans into the green box, then on the order slip write down number 5, and place them facing down on each of the orange box. In the blue dashed line circle, the instructor need to put the cut order slips of package 0.





## Appendix F Cocoa-Chocolate Supply Chain Game Section II Round 1 Player Instruction

### Round 1 Game Instruction-Retailer

#### About the Game

This game board represents the cocoa-chocolate supply chain structure, the chips on the board representing the in transit inventory and warehouse inventory.

- Form a group with 5 people and have each person take a work unit as shown in Diagram 1. Each round will have 11 cycles, each cycle representing 1 working day
- In Diagram 1, your unit contains 3 different colored/shaped boxes, and 1 picture with the name of your role. The blue dashed circle box is incoming order from your direct customer, the orange box is the order you will place with your direct vendor, the green box is the product you received from your direct vendor

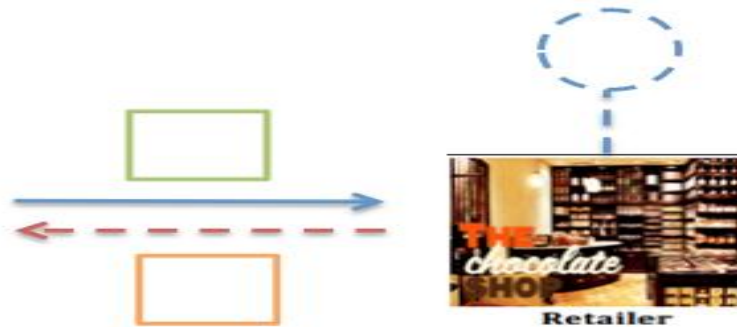
#### Steps:

- First, get the order from the blue dashed circle box, write the exact same number on to the order slip, place your order slip into the orange box with the requested product quantity facing down (Your instructor has completed this step for you in the first cycle)
- Next, move the goods from the green box into your warehouse (the picture area)
- Then move the goods to your customer(the plastic container on your right) according to the order you got from the blue dashed circle as in the first step

#### Note:

- For round one, there is no communication between the team
- Always place your order before you see your incoming customer order
- When placing your order, make sure the quantity is face down so no one can see it
- It is very important for the team to keep the same pace
- If a backlog occurred, combine the backlogged quantity with the current order quantity and send the total amount to the customer
- Please observe your inventory level throughout the process

Diagram 1



### Round 1 Game Instruction- Manufacture

#### About the Game

This game board represents the cocoa-chocolate supply chain structure, the chips on the board representing the in transit inventory and warehouse inventory.

- Form a group with 5 people and have each person take a work unit as shown in Diagram 1. Each round will have 11 cycles, each cycle representing 1 working day
- In Diagram 1, each unit contains 4 colored boxes, and 1 picture with the name of your role. The orange box on your right is the incoming order from your direct customer, the orange box on your left is the order you will place with your direct vendor, the green box on your right is the products you send out to fulfill your direct customer's order and the green box on your left is the product you received from your direct vendor

#### Steps:

- First, place your order using a paper order slip into the orange box on your left with the requested product quantity facing down (Your instructor has completed this step for you in the first cycle)
- Now move all of the goods from the green box on your left into your warehouse
- Receive the order from the orange box on your right, and deliver order accordingly from your warehouse to the green box on your right

#### Note:

- For round one, there is no communication between the team
- Always place your order before you see your incoming customer order
- When placing your order, make sure the quantity is face down so no one can see it
- It is very important for the team to keep the same pace
- If a backlog occurred, combine the backlogged quantity with the current order quantity and send the total amount to the customer
- Please observe your inventory level throughout the processes

Diagram 1



### Round 1 Game Instruction- Importer

#### About the Game

This game board represents the cocoa-chocolate supply chain structure, the chips on the board representing the in transit inventory and warehouse inventory.

- Form a group with 5 people and have each person take a work unit as shown in Diagram 1. Each round will have 11 cycles, each cycle representing 1 working day
- In Diagram 1, each unit contains 4 colored boxes, and 1 picture with the name of your role. The orange box on your right is the incoming order from your direct customer, the orange box on your left is the order you will place with your direct vendor, the green box on your right is the products you send out to fulfill your direct customer's order and the green box on your left is the product you received from your direct vendor

#### Steps:

- First, place your order using a paper order slip into the orange box on your left with the requested product quantity facing down (Your instructor has completed this step for you in the first cycle)
- Now move all of the goods from the green box on your left into your warehouse
- Receive the order from the orange box on your right, and deliver order accordingly from your warehouse to the green box on your right

#### Note:

- For round one, there is no communication between the team
- Always place your order before you see your incoming customer order

- When placing your order, make sure the quantity is face down so no one can see it
- It is very important for the team to keep the same pace
- If a backlog occurred, combine the backlogged quantity with the current order quantity and send the total amount to the customer
- Please observe your inventory level throughout the process

Diagram 1



### Round 1 Game Instruction- Farmer

#### About the Game

This game board represents the cocoa-chocolate supply chain structure, the chips on the board representing the in transit inventory and warehouse inventory.

- Form a group with 5 people and have each person take a work unit as shown in Diagram 1. Each round will have 11 cycles, each cycle representing 1 working day
- Your unit contains 3 different colored boxes, 1 orange box, 1 green box and 1 picture with the name of your role. The orange box is the incoming order from your direct customer and the green box is the products you send out to fulfill your direct customer's order
- You will have a box of raw material on your right hand side to fulfill your warehouse whenever you want.

#### Steps:

- Receive the order from the orange box, and deliver order accordingly from your warehouse to the green box
- Assume you have unlimited good supply from your box, when you run out of good, please notify your instructor for help

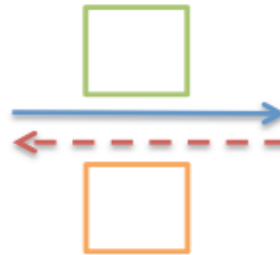
#### Note:

- For round one, there is no communication between the team
- Always place your order before you see your incoming customer order
- When placing your order, make sure the quantity is face down so no one can see it
- It is very important for the team to keep the same pace
- If a backlog occurred, combine the backlogged quantity with the current order quantity and send the total amount to the customer
- Please observe your inventory level throughout the process

Diagram 1



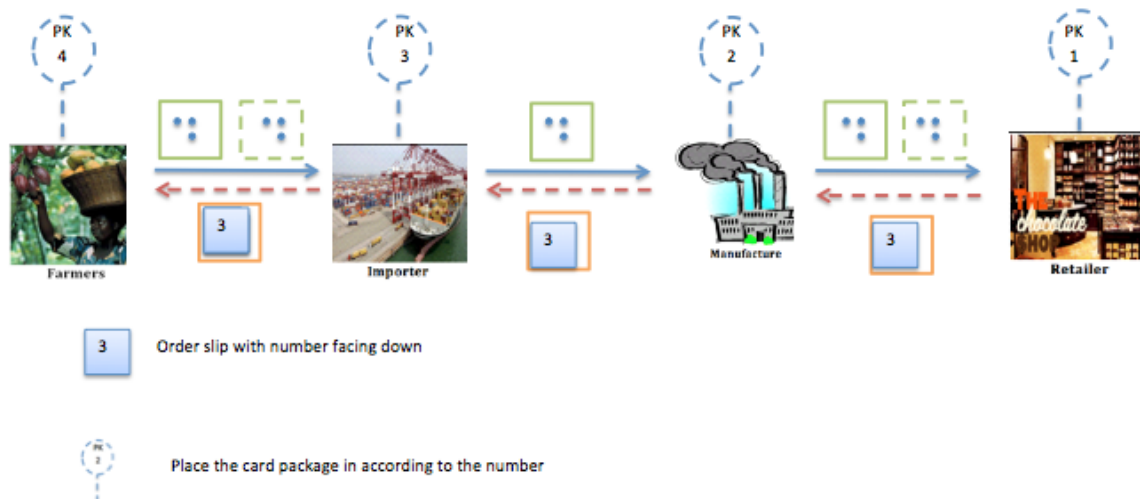
Farmers



## Appendix G Cocoa-Chocolate Supply Chain Educational Game Section II Round 1 Board

### Initialization

The board initialization will need coffee beans, which will be served as the good. The quantity and position for putting the beans is shown on the game board below. And the quantity on the order slip is shown on the game board initialization diagram below. The instructor needs to cut the different packages into cards and place them into the position indicated below. The cards for package 2-4 need to be shuffled. In addition, the instructor needs to prepare enough paper for the group to place order. Also, the instruction (see Appendix 4H) for playing the game need to distribute to the participants prior the game start.

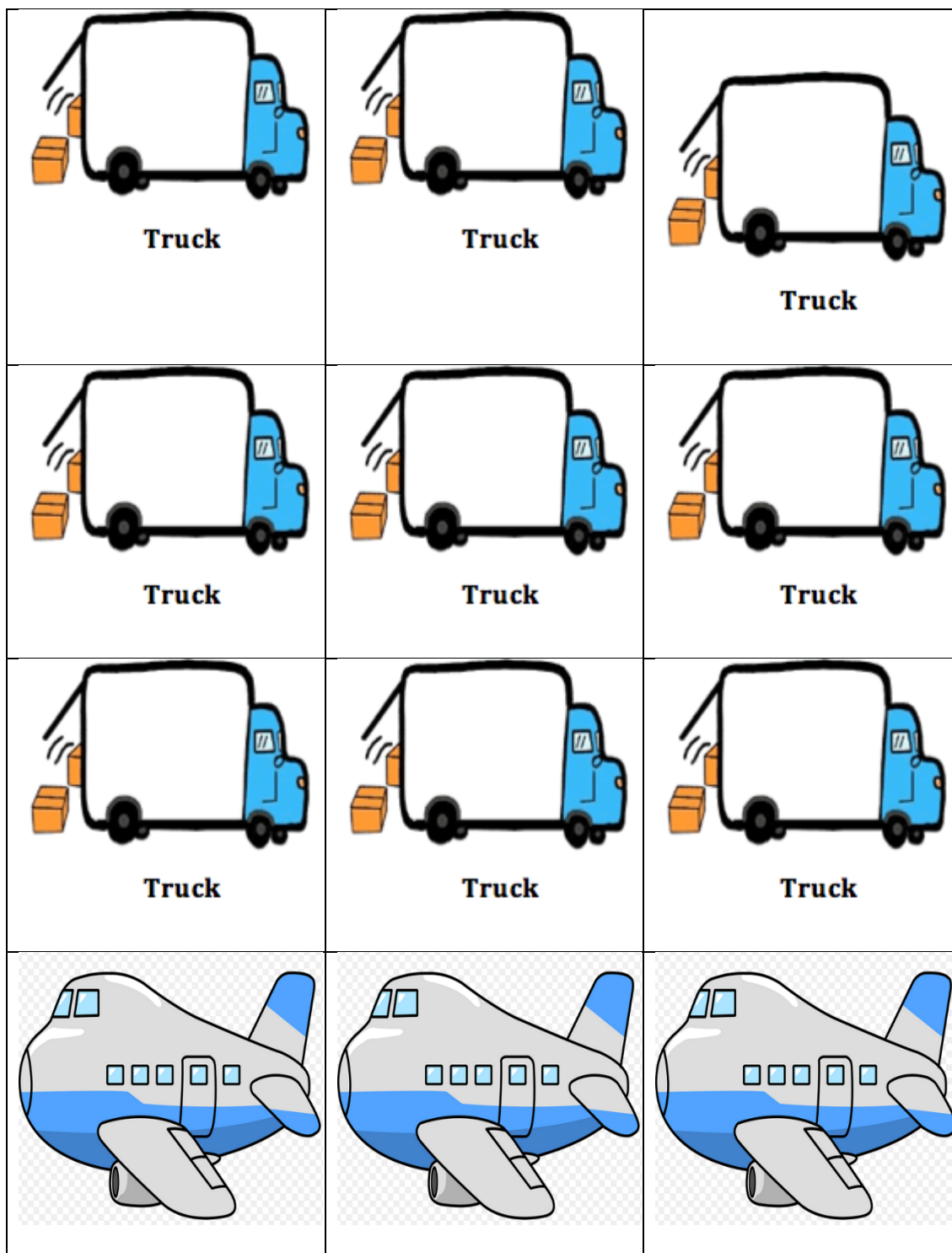


The instructor need to put 3 coffee beans into the green box, then on the order slip write down number 3, and place them facing down on each of the orange box. In the blue dashed line circle, the instructor need to put the cut order slips of package 1-4 as indicated.

## Package 1- Order slip for round 2

1 3	2 4	3 4
4 6	5 4	6 6
7 4	8 12	9 14
10 15	11 15	12

## Package 2 – Transportation tools for Manufacturer

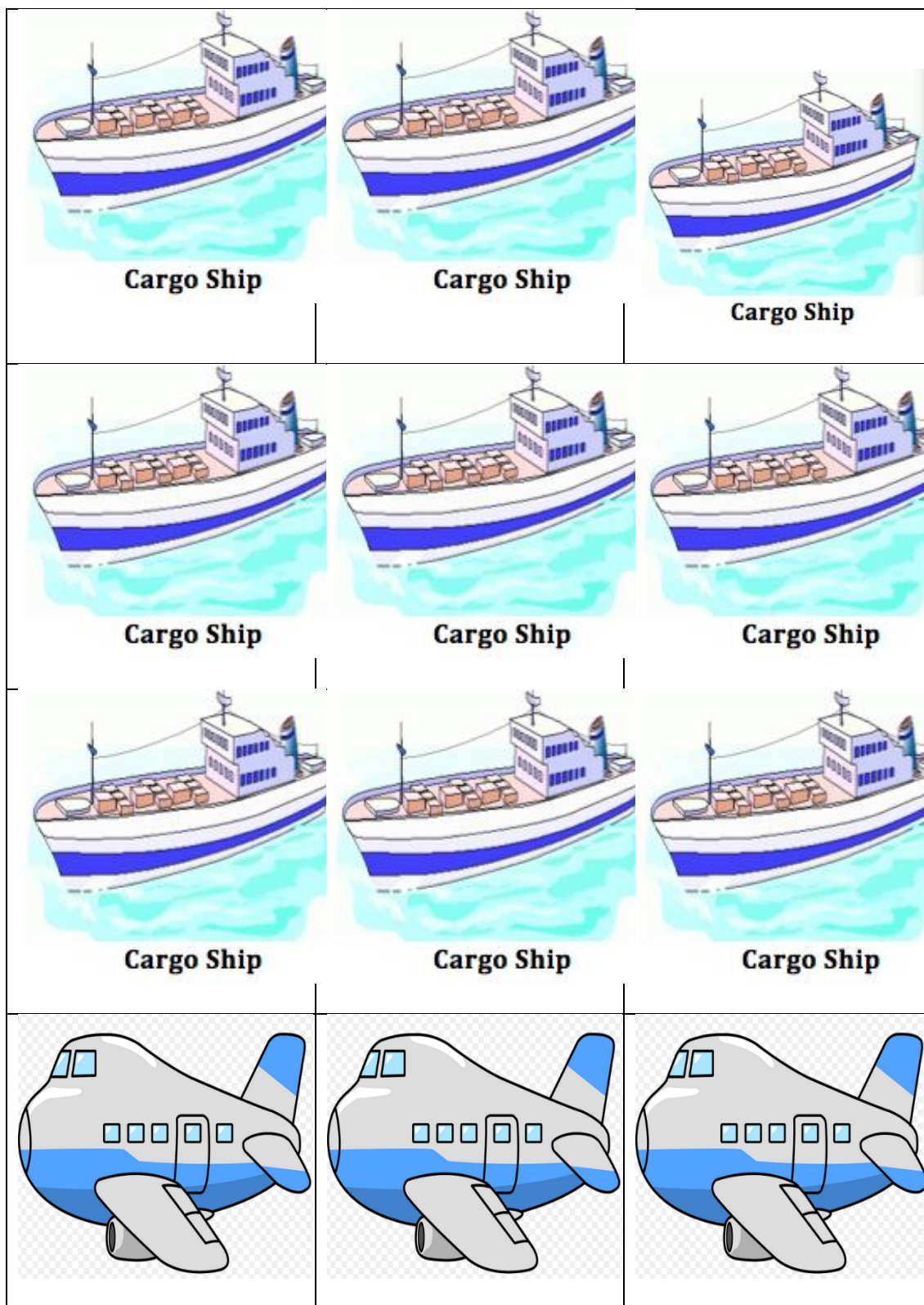




## Package 3 – Pass or Non-Pass slips for Importer

Pass	Pass	Pass
Pass	Pass	Pass
Pass	Pass	Pass
Pass	Pass	Pass
Pass	NON-Pass	NON-Pass

## Package 4- Transportation Tools for Farmer



## Appendix H Cocoa-Chocolate Supply Chain Game Section II Round 2 Player Instruction

### Round 2 Game Instruction-Retailer

#### About the Game

This game board represents the cocoa-chocolate supply chain structure, the chips on the board representing the in transit inventory and warehouse inventory.

- Form a group with 5 people and have each person take a work unit as shown in the purple square in Diagram 1. Each round will have 11 cycles, each cycle representing 1 working day
- In Diagram 1, your unit contains 3 different colored/shaped boxes, and 1 picture with the name of your role. The blue dashed circle box is incoming order from your direct customer, the orange box is the order you will place with your direct vendor, the green box is the product you received from your direct vendor

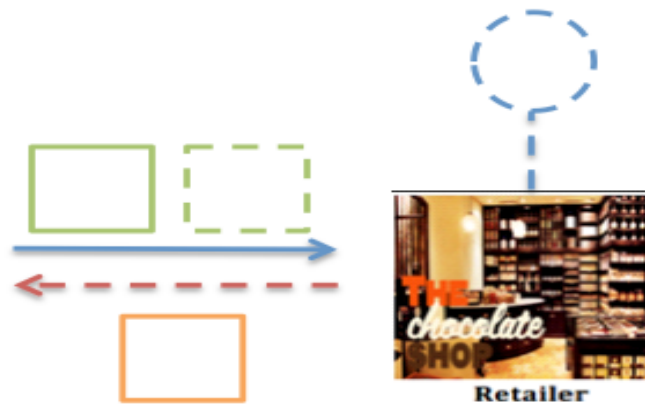
#### Steps:

- First, get the order from the blue dashed circle box, write the number of goods you want based on the number you saw from the order on the order slip, place your order slip into the orange box with the requested product quantity facing down (Your instructor has completed this step for you in the first cycle) This time you may decide how many goods you want to purchase at once, you may keep certain amount of inventory, bundle your purchase quantity or still purchase the known amount on the customer order.
- Next, move the goods from the green solid box into your warehouse (the picture area)
- Then move the goods to your customer (the plastic container on your right) according to the order you got from the blue dashed circle as in the first step

#### Note:

- For round 2 you will have limited communication opportunities, you can communicate with your group every other cycle
- Always place your order before you see your incoming customer order
- When placing your order, make sure the quantity is face down so no one can see it
- It is very important for the team to keep the same pace
- If a backlog occurred, combine the backlogged quantity with the current order quantity and send the total amount to the customer
- Please plot the order quantity from the customer at the end of the game

Diagram 1



### Round 2 Game Instruction- Manufacturer

#### About the Game

This game board represents the cocoa-chocolate supply chain structure, the chips on the board representing the in transit inventory and warehouse inventory.

- Form a group with 5 people and have each person take a work unit as shown in the purple square in Diagram 1. Each round will have 11 cycles, each cycle representing 1 working day
- In Diagram 1, each unit contains 4 colored boxes, and 1 picture with the name of your role. The orange box on your right is the incoming order from your direct customer, the orange box on your left is the order you will place with your direct vendor, the green box on your right is the products you send out to fulfill your direct customer's order and the green box on your left is the product you received from your direct vendor

#### Steps:

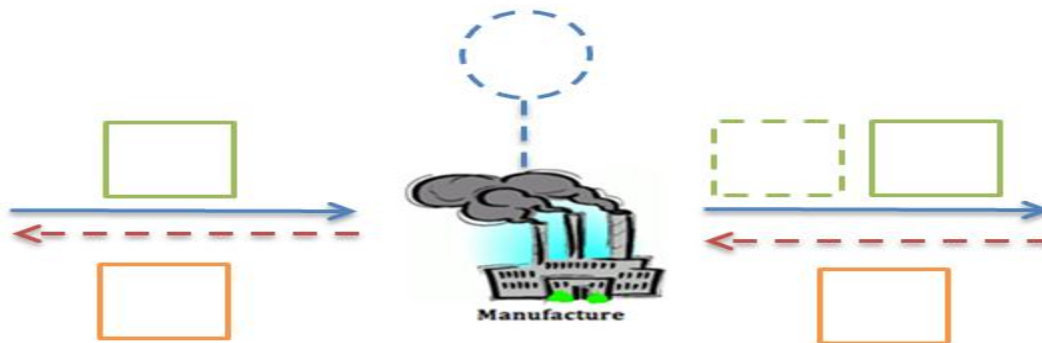
- First, place your order using a paper order slip into the orange box on your left with the requested product quantity facing down (Your instructor has completed this step for you in the first cycle)
- Now move all of the goods from the green solid line box on your left into your warehouse
- Receive the order from the orange box on your right
- Draw a card from the blue dashed line circle, this will tell you what your transportation tool is for this cycle. You may get either a truck or airplane as your transportation tool. The shipment delay for a truck is 2 days, for the airplane is 1 day.

- If you get a truck card, then put the good into the first shipment delay (the green dashed line box), in the next cycle, move the good to the 2<sup>nd</sup> shipment delay (green solid line box) on your left.
- If you get an airplane card, place the good directly into the second shipment delay (green solid line box)

**Note:**

- For round 2 you will have limited communication opportunities, you can communicate with your group every other cycle
- Always place your order before you see your incoming customer order
- When placing your order, make sure the quantity is face down so no one can see it
- It is very important for the team to keep the same pace
- If a backlog occurred, combine the backlogged quantity with the current order quantity and send the total amount to the customer

Diagram 1



## Round 2 Game Instruction- Importer

### About the Game

This game board represents the cocoa-chocolate supply chain structure, the chips on the board representing the in transit inventory and warehouse inventory.

- Form a group with 5 people and have each person take a work unit as shown in the red square in Diagram 1. Each round will have 11 cycles, each cycle representing 1 working day
- In Diagram 1, each unit contains 4 colored boxes, and 1 picture with the name of your role. The orange box on your right is the incoming order from your direct customer, the orange box on your left is the order you will place with your direct vendor, the green box on your right is the products you send out to

fulfill your direct customer's order and the green box on your left is the product you received from your direct vendor

**Steps:**

- First, place your order using a paper order slip into the orange box on your left with the requested product quantity facing down (Your instructor has completed this step for you in the first cycle)
- Now move all of the goods from the green solid line box on your left into your warehouse
- Receive the order from the orange box on your right
- Then you will need to draw the pass/non-pass slip from the blue dashed line circle as shown in Diagram 1, this is the test from US FDA
- If you got a pass slip, you can deliver order accordingly from your warehouse to the green box on your right, move the goods into the green solid line box on your right
- If you got a non-pass slip, you will need to empty your warehouse and put all the coca-beans into the recycle bin in front of you. You could not send anything to Manufacturer, so you will not put goods into the green box, instead you just put the non-pass slip into the green box

**Note:**

- For round 2 you will have limited communication opportunities, you can communicate with your group every other cycle
- Always place your order before you see your incoming customer order
- When placing your order, make sure the quantity is face down so no one can see it
- It is very important for the team to keep the same pace
- If a backlog occurred, combine the backlogged quantity with the current order quantity and send the total amount to the customer

Diagram 1



## Round 2 Game Instruction- Farmer

### About the Game

This game board represents the cocoa-chocolate supply chain structure, the chips on the board representing the in transit inventory and warehouse inventory.

- Form a group with 5 people and have each person take a work unit as shown in the red square in Diagram 1. Each round will have 11 cycles, each cycle representing 1 working day
- Your unit contains 3 different colored boxes, 1 orange box, 1 green box and 1 picture with the name of your role. The orange box is the incoming order from your direct customer and the green box is the products you send out to fulfill your direct customer's order
- You will have a box of raw material on your right hand side to fulfill your warehouse whenever you want.

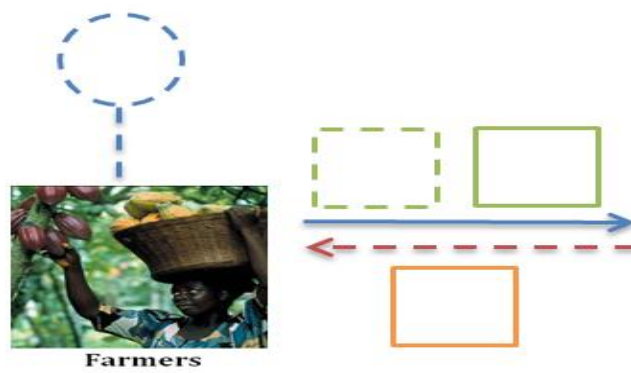
### Steps:

- First, place your order using a paper order slip into the orange box on your left with the requested product quantity facing down (Your instructor has completed this step for you in the first cycle)
- Receive the order from the orange box on your right
- Draw a card from the blue dashed line circle, this will tell you what your transportation tool is for this cycle. You may get either a truck or a cargo ship as your transportation tool. The shipment delay for a cargo ship is 2 days, for the airplane is 1 day.
  - If you get a cargo ship card, then put the good into the first shipment delay (the green dashed line box), in the next cycle, move the good to the 2<sup>nd</sup> shipment delay (green solid line box) on your left.
  - If you get an airplane card, place the good directly into the second shipment delay (green solid line box)

### Note

- For round 2 you will have limited communication opportunities, you can communicate with your group every other cycle
- Always place your order before you see your incoming customer order
- When placing your order, make sure the quantity is face down so no one can see it
- It is very important for the team to keep the same pace
- If a backlog occurred, combine the backlogged quantity with the current order quantity and send the total amount to the customer

Diagram 1





Appendix I    Cocoa-Chocolate Supply Chain Educational Game Section II Round 1  
Introduction

## Cocoa-Chocolate Supply Chain Educational Game

Section II Round 1  
Introduction

### Overview

- Relevant Concepts
- Tools
- Game Board
- Game Introduction
- Rules

## Concepts

- Direct customer: The person on your left
- Direct vendor: The person on your right
- Cycle: The process of placing one order till receive the good for this order
- Upstream: The direction of the material flow
- Downstream: Opposite direction of the material flow
- Order backlog: Customer order placed but not received

## Tools

- Stick Note: order slip
- Cocoa-Beans: represent the goods
- Record Form: record good received and sent out, calculate inventory and/or backlog

## Game Board

- The supply chain system shown on the game board is the key structure of cocoa-chocolate supply chain and the simulation will be based on this system
- There is one shipment delay between each direct customer and vendor
- The green box is for you to place order
- You will receive the goods from the orange box
- You will run your own warehouse in the box with your role written
- The orange arrows representing the direction of good flow, the blue arrows representing the direction of information flow

## Game Introduction

- You will be divided into groups, each group will have 5 person, each person will have chance to pick one role
  - Supplier
  - Importer
  - Manufacture
  - Retailer
  - Time Keeper
- The game will have two rounds and each round will have 15 cycles
  - The first round is a introduction round, you will get familiar with the game
  - The second round will involve more strategic planning

## Game Introduction

- You major tasks will be place order, receive order, send order and accept deliver (However, part of the tasks various according to your role, please see your job description for specific instruction)
  1. Write the order number on the stick notes, and place the order with number facing down in the green box on your right
  2. Pick up the order from your direct customer from the green box on your left
  3. Remove all the goods from the orange box on your right
  4. Send the good to the orange box on your left according to the order slip from the green box

## Note

- NO communication allowed
- Please read and follow your role instruction to complete your tasks
- Please record your backlog and inventory on the Record Form for each order your placed
- Please keep your pace according to the time keeper's announcement

Appendix J    Cocoa-Chocolate Supply Chain Educational Game Section II Round 1  
Debriefing

## Cocoa-Chocolate Supply Chain Educational Game

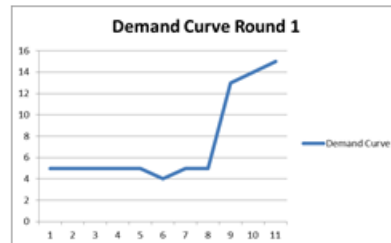
Section II Round 1- Debriefing

### Rate Your Performance

- Is there any backlog or too much inventory in the process?
- If yes, why did this happen?
- What are some suggested strategies to improve the supply chain performance?
- What is some necessary information that could help improve the supply chain performance?
- Have you see any pattern for the demand quantity?

## Demand Curve

- Plot your demand curve and see if there is a specific pattern.
- If yes, why this happened?



## Hockey-Stick Phenomenon

- Definition - The 'Hockey-Stick Phenomenon' refers to a large product demand occurring over several days in a fixed period, preceded by relatively small demand for the rest of the period, which forms a 'hockey stick shaped' graph. (Snyder & Shen, 2011)
- Effect –
  - Unstable and uncertain quantities of requested products.
  - The variance and irregular demand curve will eventually cause variable cost and resources waste to rise.

## Stimuli

- Desire to meet the sales requirement and increase sales revenue.
- Prepare for an expected price increase at the beginning of the next sales period.
- Main retailers put pressure on manufacturers to reach their negotiation goal

## What Can We Do?

Awareness

**STRATEGIES**

Communication

### Additional Information for Round 2

- Manufacture-Certification non-pass possibility
- Importer, Farmer-Transportation time variance
- Limited communication allowed for every other round
- The demand curve will follow the same shape but with different number

### DISCUSS YOUR STRATEGY

- How to deal with the hockey stick phenomena
- How to deal with the un-pass raw material effect
- How to use you communication opportunity efficiently
- How to respond to different shipment delays?



Appendix K Cocoa-Chocolate Supply Chain Educational Game Section II Round 2  
Debriefing

## Cocoa-Chocolate Supply Chain Educational Game

Section II Round 2- Debriefing

### Compare to Round 1

- What is your strategy? What was your result?
- What changed compared to Round 1? More/less backlog or Inventory?
- Did the ability to communicate with the other groups help? Why or why not?
- What could be improved if we played one more round?

## International Trade

- Communications will be delayed because of time difference, language bias, company culture etc
- Government policy and quality check is strict
- Risk in transit

## Deal with Shipment Delay Variance

- Bundle purchase
- Safety inventory
- Choose reliable supplier or fleet service

### Reduce the Occurrence/Influence of Hockey-Stick Phenomena

- Sales- Modify company policy on bonus for sales personnel
- Manufacturing-Increase forecasting accuracy, develop healthy relationship with sales sector, reduce communication lead time with supplier, keep safety stock

### Summary

- Hockey-Stick Phenomena(Definition, Stimuli, Solutions)
- Cocoa-Chocolate Supply Chain (General structure, functions)
- International Trade

End of The Game

**Please Finish Your Survey!**

**Thank you! Danke!**

## Appendix L Facilitator Set-up Guide

1. Set-up the game board for Section I by distributing each group with a set of gaming card shown in Appendix 4A and a Gaming Board as shown in Figure 4.2.
2. Show the students the presentation slides shown in Appendix 4B and 4C to provide participants necessary background knowledge.
3. Guide participants through the first section activities, and involve them with discussions about obstacles within this process.
4. Show students the presentation shown in Appendix 4D to debrief the game.
5. Set-up the game board for Section II round 1 according to Appendix 4E, distribute each group with 5 stacks of stick-notes, one bag of coffee beans and a set of role instructions as shown in Appendix 4F.
6. Shown students the slides shown in Appendix 4I to introduce them with this gaming section.
7. Guide students play the game, and then show them the debriefing slides in Appendix 4J.
8. Set-up the game board for Section II round 2 according to Appendix 4G, distribute each group with 5 stacks of stick-notes, one bag of coffee beans and a set of role instructions as shown in Appendix 4H.
9. Guide students play the game, and then show them the debriefing slides in Appendix 4K to conclude the game.

## Appendix M Cocoa-Chocolate Supply Chain Educational Game Survey

### Survey for Chocolate Supply Chain Educational Game

Please circle the rate the following topics according to your understanding of the game  
(1 is the lowest and 9 is the highest)

#### 1. Knowledge of basic concepts related to supply chain

Before 1 2 3 4 5 6 7 8 9

After 1 2 3 4 5 6 7 8 9

#### 2. Familiarity with cocoa-chocolate supply chain

Before 1 2 3 4 5 6 7 8 9

After 1 2 3 4 5 6 7 8 9

#### 3. Understanding of the key concepts related to Hockey-Stick Phenomenon

Before 1 2 3 4 5 6 7 8 9

After 1 2 3 4 5 6 7 8 9

#### 4. Knowledge of the Hockey-Stick Phenomenon

Before 1 2 3 4 5 6 7 8 9

After 1 2 3 4 5 6 7 8 9

#### 5. Knowledge of the difference between international trade and domestic trade

Before 1 2 3 4 5 6 7 8 9

After 1 2 3 4 5 6 7 8 9

#### 6. Willingness to participate in an educational game

Before 1 2 3 4 5 6 7 8 9

After 1 2 3 4 5 6 7 8 9